

I. Background Information/Finding of Fact

- A. MRGB Characteristics
- B. Geology
- C. Oil and Gas Potential
- D. Drilling and Productions Techniques
- E. Water Resources
- F. Regulatory Authority
- G. Community Concerns
- H. Synopsis of other Ordinances (Link [here](#))

To be completed by end of July

II. Legal Basis and Limitations of County and Local Ordinance and Regulations

- A. Scope/preemption by Federal and State requirements
- B. Limitations of local ordinances on Federal, State, and Tribal lands
- C. Existing governance permitting and reporting requirements (i.e. identification of key process and technical reports of potential interest to local entities)
- D. Potential for consideration of a presumptive liability approach as a legal basis for County ordinance
- E. Issues of governmental “takings” and process relief

Dan to complete by July with August legal review

III. Water Resource Protection Issues (End of September Final draft)

- A. Basis for water resource protection guidelines / subsurface process regarding fracturing / statement of risks Steve
- B. Use of freshwater resources for oil and gas activity (Office of the State Engineer interaction and permitting requirements, amounts, escalating use of treated/produced water) Bruce
- C. Potential for contamination of ground water supplies from subsurface drilling activities Bart and Bruce
 - Approach for baselining water resources and determination of sources of oil and gas contamination / set-back requirements
 - Publication of injection fluids and toxicity risks / proprietary information?
 - Cementing and casing recommendations/inspection/ enforcement
 - On-going monitoring requirements
 - Consideration of tagging requirement / unique tracer
- D. Potential for contamination of surface water supplies from surface and transportation activities Bart
 - Provisions for siting including source area protection measures and well head set back and spill control
 - Provisions for municipal and private well users/notification requirements
- E. Disposal and reuse of flow-back and fracking fluid and produced water Bruce

IV. Emergency Response Planning (complete by early December - Dan)

- A. Basis
- B. Emergency Services Limitations (County/municipal)

- C. On-call response guarantees / protocols
 - Active drilling operations
 - Production activities
 - Abandoned / Shut-in wells
 - Pipeline leaks and spills
 - Roadway transportation incidents
 - D. Emergency and Contact information currency
 - E. Community Notification Plans
- V. Local Permitting Requirements and Inspection/Enforcement Structure
- A. Adequate information for plan review and community notification
 - B. Appropriate and adequate technical capacity for plan review
 - C. Special use and/or well permit requirement (analog of special use and building permits and inspection)
 - Siting constraints (Wildlife and habitat protection /Archeological and cultural properties/ concept of siting as a distributed industry versus single site permitting / cross-jurisdictional boundary considerations)
 - Competence to perform a technical operation
 - Land owner agreements and access
 - D. Risk / consequence consideration
 - Exclusion areas (high consequence area)
 - Mandatory set-backs (protection basis)
 - Provisional set-backs (based on nature or type of facility and risk)
 - E. Fee Structure / Payment to Entity for contracted plan review services
 - F. Enforcement efforts gauged to phase of operations (exploration, development, production, abandonment)
 - Seismic survey permits and requirements
 - Site / surrounding environmental baselining
 - Exploratory / single well requests
 - Hours of Access and Operations
 - Development and Production
 - Multi-well vs single well completions and pad sites and regulatory permitting nuances
 - Collection and Gathering facilities and pipelines
 - Hours of Access and Operations
 - Gas and oil collections pipelines and facilities / protections and set-back
 - Shut-in and Abandonment
 - Site Restoration
- VI. Appropriate and Adequate Technical Capacity/Responsibilities for Inspection and Enforcement
- A. Scope of enforcement duties
 - B. Frequency of inspection based on enforcement area
 - C. Interaction with regulating agencies
 - D. Right for entry and review of records
 - E. Provision for emergency enforcement
 - F. Fee Structure / Payment to Entity for contracted services

- G. Penalty provisions
- VII. Operations and Surface Transportation Planning
 - A. Basis
 - B. Restricted access routes / Load Limitations
 - C. Hours of Access and Operations
 - D. Gas and oil collections pipelines and facilities / protections and set-backs
- VIII. Air Quality Protection
 - A. Basis for concern and mitigation
 - B. Off gassing during active oil and gas operations
 - C. Methane venting and flaring
 - D. Diesel equipment and generator operations
 - E. Dust control
- IX. Noise and Lighting Protection
 - A. Basis for concern
 - B. Baselineing
 - C. Mitigation Measures
- X. Site Fencing, Access, Notification, and Posting
 - A. Basis for concern
 - B. Requirements
 - C. Oil and Gas Deed Recordation
- XI. Economic Impact Issues
 - A. Basis
 - B. Threshold of oil and gas activity to trigger improvements
 - C. Housing Plan for temporary workforce increases
 - D. Mitigation of impact on community resources and infrastructures including schools
 - E. Impact fee determinations
 - F. Property value impacts (possible devaluation for adjacent owners)
 - G. Environmental Justice issues
- XII. Financial Assurance Requirements
 - A. Basis for costs for liabilities, clean-up and abandonments
 - B. General Liability and Environmental Liability Protections
 - C. Bonding to ensure adequate maintenance and closure and abandonment of oil and gas wells
 - D. Time period for which bonding must be maintained, released, and any scaling based on number of wells drilled and/or in production
 - E. Exploration vs Development Considerations (seismic, exploratory vs field development, abandonment phase outs).

Acronyms

Figures

Tables

References

Appendices



MID-REGION
Council of Governments

WATER RESOURCES BOARD
TECHNICAL ADVISORY GROUP

GUIDELINES FOR OIL AND GAS ORDINANCES FOR MEMBER GOVERNMENTS

DATE

Table of Contents

Executive Summary	8
Introduction.....	8
I. Technical Background Information/Findings of Fact.....	9
Middle Rio Grande Basin (MRGB) – Physical Characteristics.....	9
Geology of MRGB	14
Oil and Gas Resources.....	17
Oil and Gas potential in the MRGB	17
Drill and O&G Production Techniques	19
Water Use and Fracking.....	19
Management of Flowback and Produced Water from the Fracking Process:	22
Water Resources	24
Regulatory Authority	26
Federal Acts and Provisions.....	26
State Acts and Provisions.....	27
Oil and Gas Act.....	28
Surface Owners Protection Act (NMSA 1978 Ch 70 Section 12).....	33
Water Quality Act (NMSA 1978, Chapter 74-6)).....	33
New Mexico Air Quality Control Act (NMSA 1978 Chapter 74 Part 2) / Clean Air Act.....	34
Clean Air Act / Federal Methane Rules.....	37
Water Law and Role of the Office of the State Engineer (OSE).....	39
Additional State Acts and Regulations:.....	40
Regulatory Purview of Municipalities and Counties.....	40
Summary of Expert and Community Concerns.....	45
Summary of Expert Survey	46
Overview of Community Concerns.....	47
Concerns with Water Quality Impacts (Surface Water, Produced Water Management, Groundwater Pathways, Water Use).....	48
Spills and Releases.....	48
Subsurface Migration/Contamination Pathways.....	48
Pathways due to Formation Fracking.....	50
Sources/Volumes of Drilling Water	52
Concerns with Community Health Impacts.....	52
Concerns with Increased Seismicity and Earthquakes.....	54

Concerns with Effects on Local Governments	56
Santa Fe County	60
Valencia County	61
II. Legal Basis and Limitations of Local Ordinance and Regulation.	61
Preemption	61
Regulatory Takings	67
.....	73
Regulatory Approaches to Liability	73
Nuisance Regulations	80

Executive Summary

(reserved)

Introduction

The Mid-Region Council of Governments (MRCOG) Board of Directors established Resolution ([R-18-04 MRCOG](#)) on January 10, 2019 directing the Water Resources Board (WRB) to review and address concerns related to the social, economic and environmental issues associated with oil and gas development throughout the region served by the MRCOG, to seek input and information from stakeholders and to create guidelines for oil and gas ordinances for use by member governments.

The MRCOG is a multi-county governmental agency tasked with helping communities plan for the future in the areas of transportation, agriculture, workforce development, employment growth, land use, water, and economic development. The MRCOG serves in an advisory capacity, providing a neutral forum for communities, groups, individuals and member governments to meet and discuss regional issues, and has the staff resources to provide support and information to an advisory board (MRCOG, 2018).

The Chairman of the Albuquerque Bernalillo County Water Protection Advisory Board (WPAB) sent a request to the Chairman of the MRCOG Board requesting that MRCOG appoint and convene a multi-disciplinary advisory board to review the social, economic and environmental concerns associated with potential oil and gas development in the MRCOG region. The WPAB also sent letters to the City of Albuquerque and Bernalillo County recommending development and adoption of oil and gas ordinances. Other member governments of MRCOG have also considered adoption of O&G ordinances.

The WRB held a special meeting on January 9, 2019 to discuss R-18-04 MRCOG and define deliverable's. The WRB approved a Technical Advisory Group (TAG) to develop draft work plans, provide a public input mechanism, and establish a meeting schedule for development of the oil and gas ordinance guidelines. The TAG established a two year schedule to develop the O&G ordinance guidelines and has reported back to the WRB in their quarterly meetings. The WRB in turn has reported back to the MRCOG Board for review and approval.

The O&G ordinance guideline is comprised of the following major areas of concern:

- Background Information/Finding of Fact
- Legal Basis and Limitations of County and Local Ordinance and Regulations
- Water Resource Protection Issues
- Emergency Response Planning
- Local Permitting Requirements and Inspection/Enforcement Structure
- Operations and Surface Transportation Planning
- Air Quality Protection
- Noise and Lighting Protection
- Site Fencing, Access, Notification, and Posting

- Economic Impact Issues
- Financial Assurance Requirements

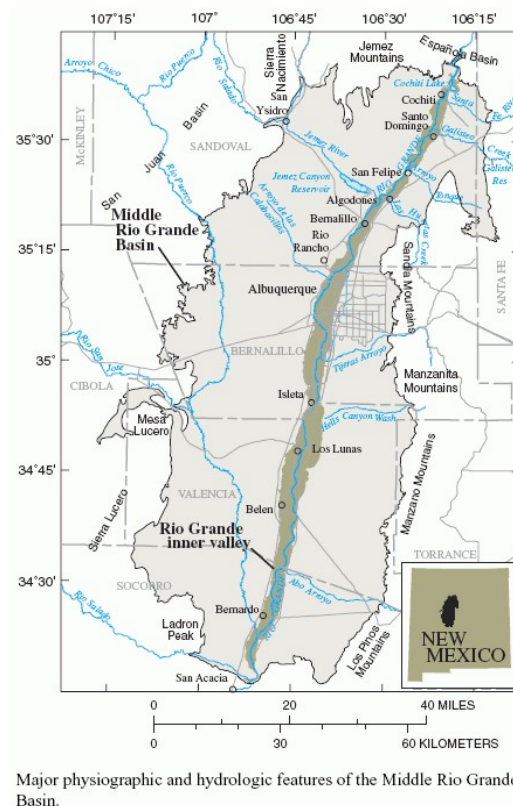
I. Technical Background Information/Findings of Fact

The geographic focus area of the oil and gas ordinance guideline is limited to the extent of the Middle Rio Grande Basin, falling within the three MRCOG member counties (Sandoval, Bernalillo, Valencia). This roughly includes the area extending from Cochiti Lake to the southern boundary of Valencia County (south of Belen) and from the Rio Puerco to the west and the Sandia, Manzano, and Los Pino Mountains to the east. The oil and gas ordinance guideline does not address geologic conditions or provisions particular to areas outside of the Middle Rio Grande Basin, though part of these guidelines may be applicable in those outside areas.

Middle Rio Grande Basin (MRGB) – Physical Characteristics

The MRGB area is presented in Figure 1 based on the United States Geological Survey (USGS) Middle Rio Grande Basin Study (Bartolino et.al, 2002). The following summarized descriptive characteristics are taken from this study.

Figure 1. Middle Rio Grande Basin



“The Middle Rio Grande Basin covers approximately 3,060 square miles in central New Mexico, encompassing parts of Santa Fe, Sandoval, Bernalillo, Valencia, Socorro, Torrance, and Cibola Counties from about Cochiti Dam to about San Acacia.

Geology: The Middle Rio Grande Basin lies in the Rio Grande rift valley, a zone of faults and basins that stretches from Mexico north to approximately Leadville, Colorado (about 150 miles north of the New Mexico border)—the modern Rio Grande follows this rift valley. The rift formed more than 25 million years ago and initially consisted of a succession of topographically closed basins. These closed basins filled with sediment from the adjacent mountain ranges, dune deposits from windblown sand, and volcanic deposits from local volcanic areas such as the Jemez Mountains. Basin-fill deposits are known as the Santa Fe Group and range from about 1,400 feet thick at the basin margins to approximately 14,000 feet in the deepest parts of the Middle Rio Grande Basin.

Surface Water: In the Middle Rio Grande Basin, the surface- and ground-water systems are intimately linked through a series of complex interactions. Besides the Rio Grande, the inner-valley surface-water system also contains a system of riverside drains, which are deep canals that parallel the river immediately outside the levees. The drains are designed to intercept lateral ground-water flow from the river, thus preventing waterlogged conditions in the inner valley.

Groundwater: The Santa Fe Group aquifer system is divided into three parts: the upper (from less than 1,000 to 1,500 feet thick), middle (from 250 to 9,000 feet thick), and lower (from less than 1,000 to 3,500 feet thick). In places, the upper part and (or) the middle part of the aquifer has eroded away. Much of the lower part may have low permeability and poor water chemistry; thus, ground water is mostly withdrawn from the upper and middle parts of the aquifer. Only about the upper 2,000 feet of the aquifer is typically used for groundwater withdrawal.

The depth to water in the Santa Fe Group aquifer system varies widely, ranging from less than 2 feet near the Rio Grande to about 1,180 feet in an area west of the river beneath the West Mesa. In 1995, the New Mexico Office of the State Engineer declared the Middle Rio Grande Basin a “critical basin”. Water enters the Santa Fe Group aquifer system in four main settings: mountain fronts and tributaries to the Rio Grande, the inner valley of the Rio Grande, the Rio Grande, and subsurface basin margins (Bartolino et.al. 2002).”

Land Use

The Mid Region Council of Governments (MRCOG) is composed of Sandoval, Bernalillo, Valencia and Torrance Counties. In this area slightly over 50% is government agency managed. Figure ? is a map of the Middle Rio Grande Basin with municipalities and county boundaries shown.

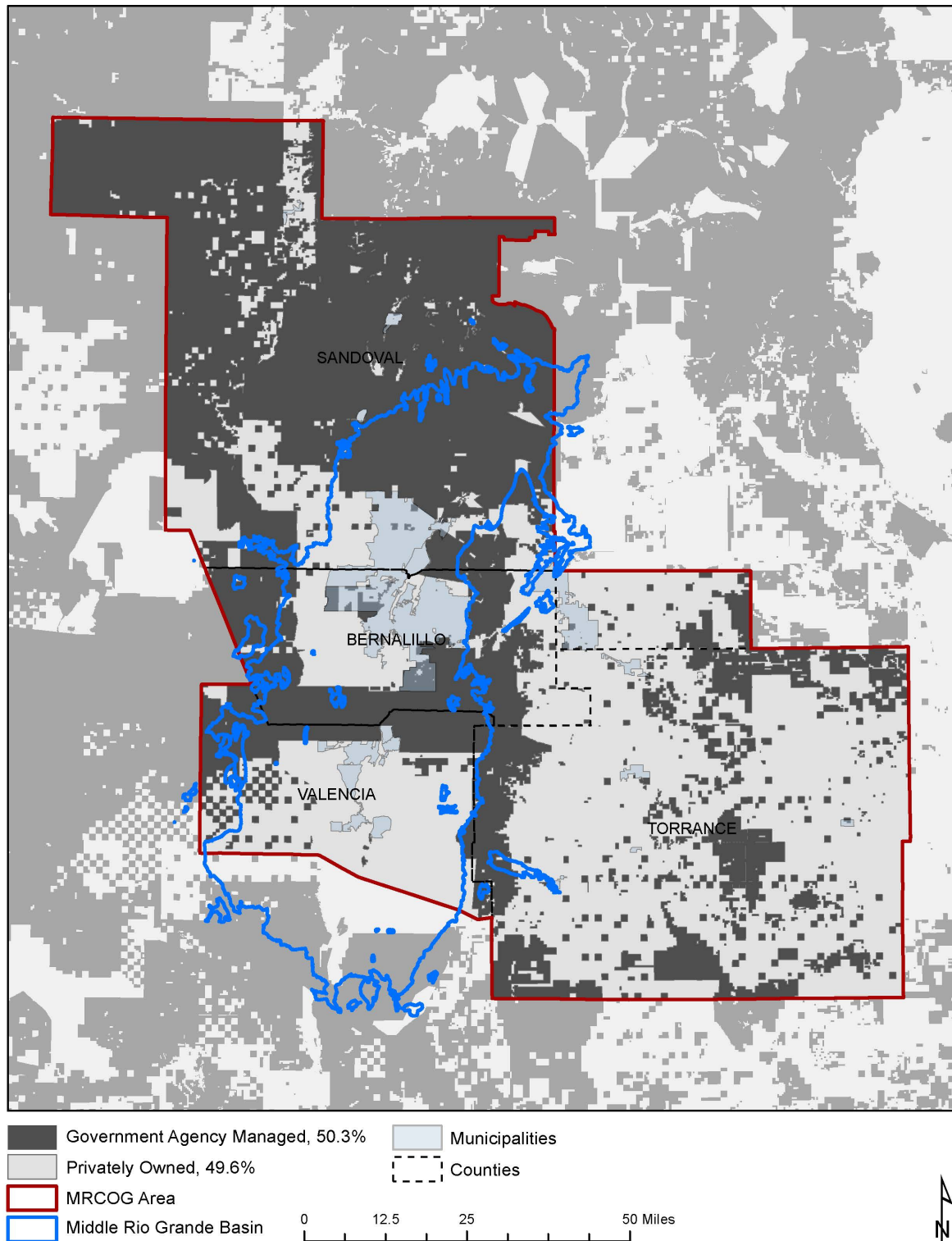


Figure ?

Property ownership may dictate if an oil and gas ordinance is applicable. For instance, a municipal or county oil and gas ordinance would not apply to tribal lands unless the specific tribe adopts such ordinance. Federal properties, such as the Forest Service, National Park Service, Department of Defense, Bureau of Land Management may not have to abide by a

local oil and gas ordinance. The following figures provide a description of land ownership with MRCOG and the Middle Rio Grande Basin overlain by county.

Sandoval County Land Ownership

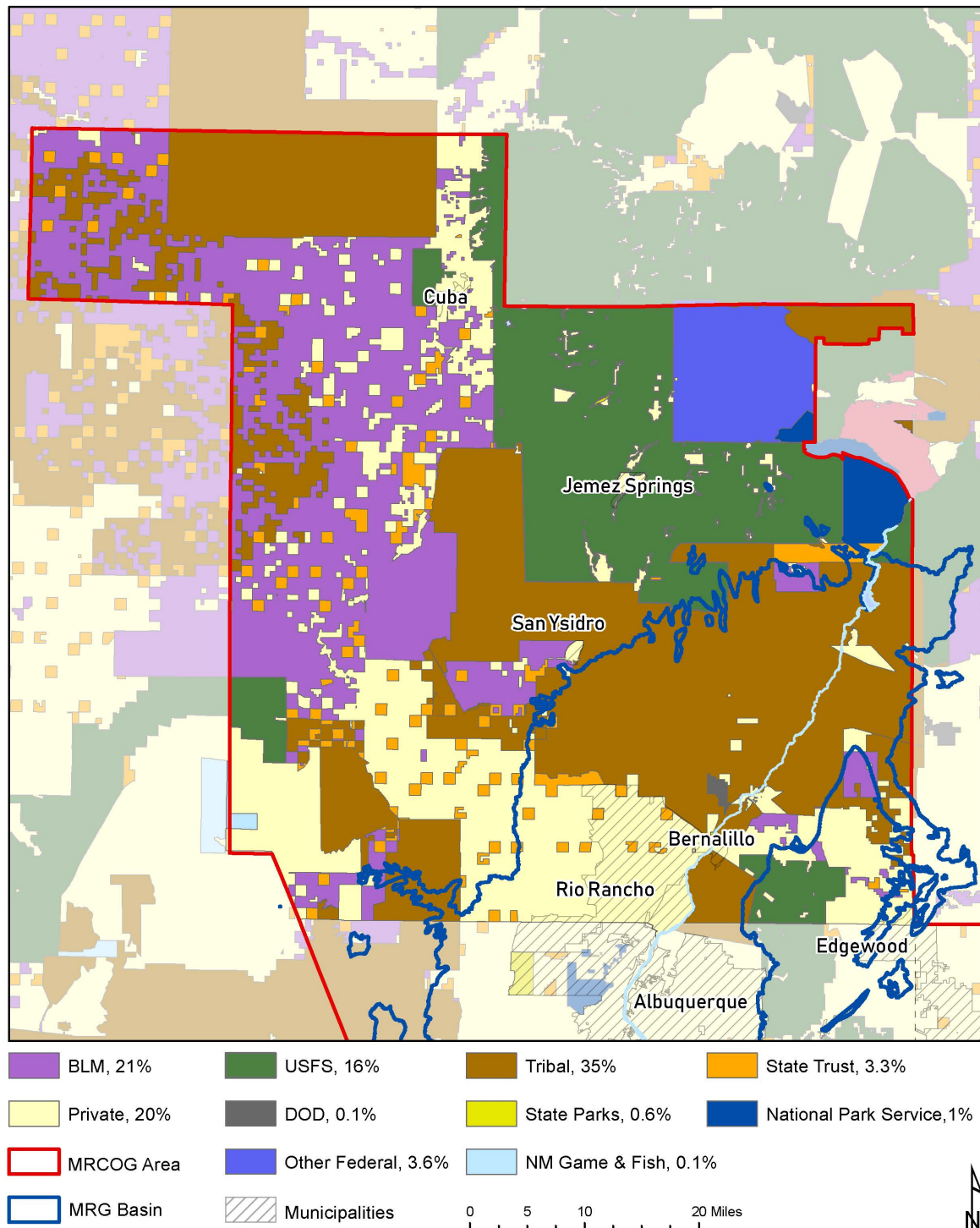


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Bernalillo County Land Ownership

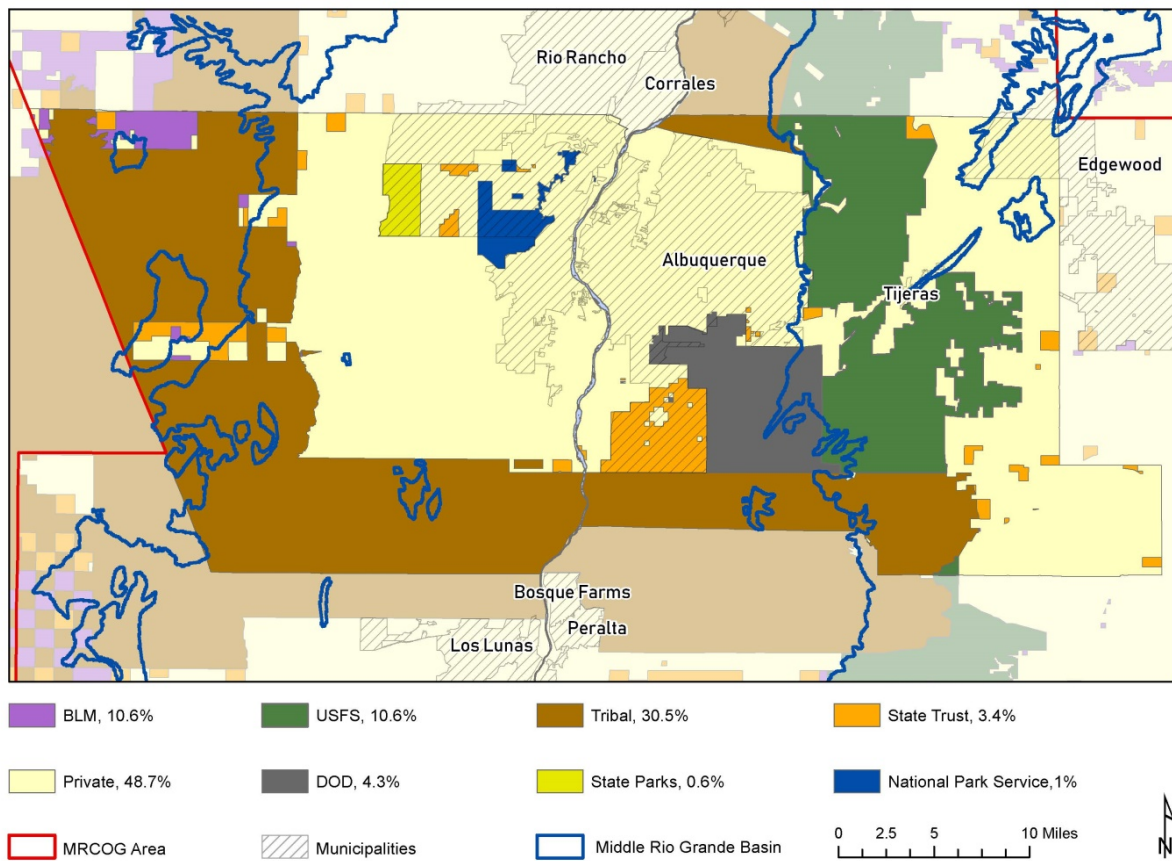


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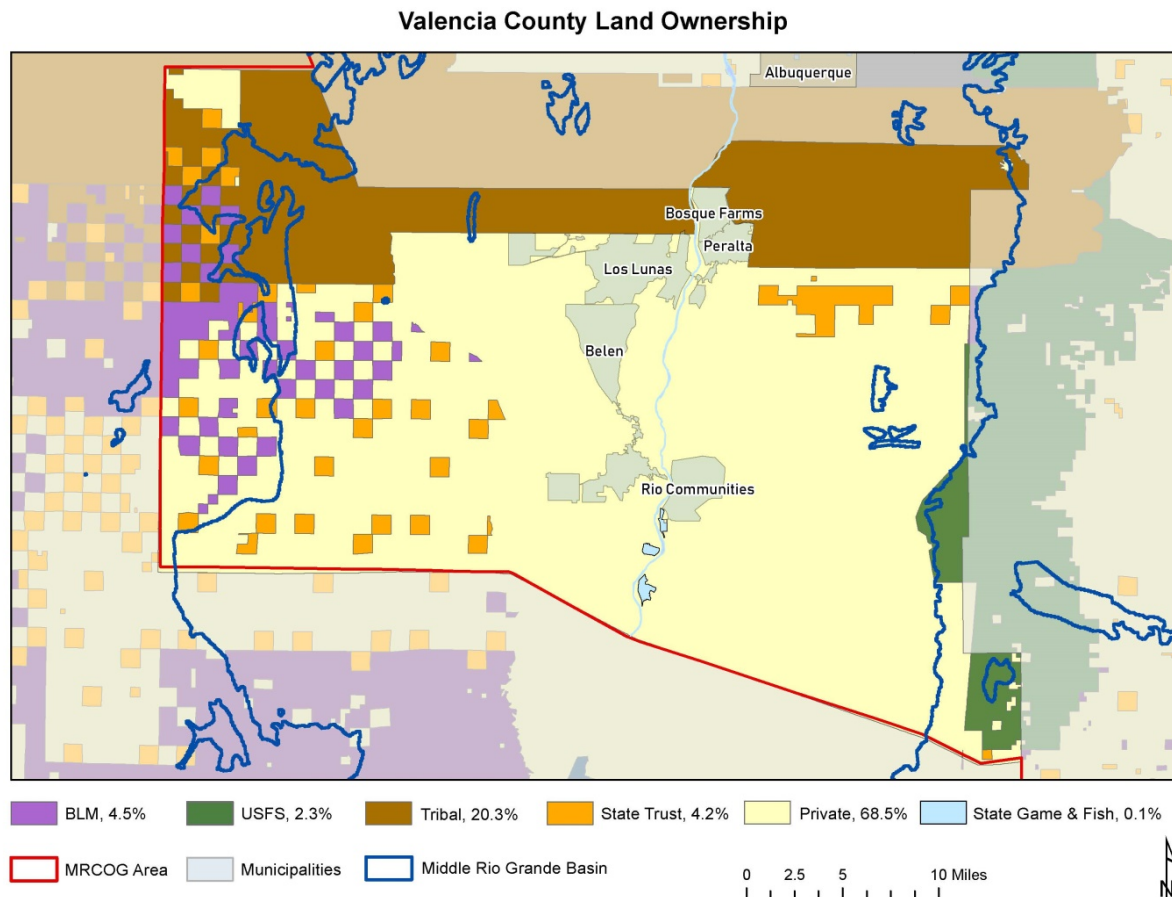


Figure ?

Other designated land uses may restrict oil and gas drilling and production within the Middle Rio Grande Basin. These land uses may include specific habitat designations (i.e. Rio Grande Bosque), endangered species areas, restrictive use covenants, etc. These restrictions are further described in Section 4.C of this guidance.

Geology of MRGB

The geology of the Middle Rio Grande Basin and the majority of the Rio Grande Valley are dominated by the Rio Grande Rift. “This Rift is one of only five young, active continental rifts in the world.” ([NM Museum of Natural History and Science](#), 2019) The Rio Grande Rift is north trending separating the Colorado Plateau to the west from the stable continental lithosphere to the east. The Rift extends from central Colorado near Leadville south into the Mexican state of Chihuahua. This Rift started about 36 million years ago when the Earth’s crust stretched and thinned in an east-west direction allowing hot mantle to upwell forming a topographically low area.

“The valleys of the Rio Grande depression are bounded by northerly striking normal faults which form when an area is under tension. This caused the valleys to drop down and the flanking mountains to rise relative to one another. The down-dropped blocks along the Rio Grande, called grabens, contain accumulation of sediments washed from surrounding highlands.” The Albuquerque Basin has most fault displacement on the east side of the rift generally causing tilted layers to the east. Through volcanic rock dating,

the rifting seems to be younger and narrower toward the north. This narrowing caused deeper basins around 14 to 16 million years ago with least amount of rifting in the last 5 million years.” (Kelley, 2012)

This whole rift consists of three major basins and multiple smaller basins. The Albuquerque Basin (Middle Rio Grande Basin) is the largest and oldest basin in the rift that filled with sandstone, siltstone, and conglomerate, primarily known as the Santa Fe Group (Kelley, 2012). The Middle Rio Grande Basin is also the deepest with largest fault displacements of all basins within the rift. Kelly was first to document the rift by northerly striking normal faults (Kelley 2012). Chapin presented a generalized map of the multiple basins in 1971, providing detailed descriptions of smaller (inflexion) and parallel basins ([Chapin](#), 1971). Hawley compiled a guidebook of the middle to late Cenozoic geology for the rift in 1978 ([Hawley](#)). The Precambrian basement in the Middle Rio Grande Basin range from around 28,500 feet below sea level to approximately 10,500 feet above sea level at the top of the Sandia Mountains (Chapin, 1994).

Connell, Allen, Hawley and Shroba provided a preliminary geologic map of the Albuquerque West Quadrangle in [1998](#). The map report identified past geologic work by multiple geologists beginning in 1908 and provides detailed geologic mapping of the Albuquerque area at a scale of 1:24,000. The report details specific post-Santa Fe group deposits as quaternary surficial deposits. These deposits are further divided into valley fill alluvium of the ancestral Rio Grande, valley fill and valley border alluvium and piedmont slope alluvium. Each of these alluviums is further delineated into specific detailed deposits. The report further details basin fill deposits of the Santa Fe group from quaternary, tertiary system deposits along with upper Miocene to Pliocene, which defines in greater detail specific formations. The map provides four cross sections through the area and specifically states:

“The cross sections are interpretive and should be used as an aid to understand the geologic framework and not used as the sole source of data in locating or designing wells, buildings, roads or other structures.” (Connell, et. al, 1998)

These cross sections provide detailed interpretive data from approximately 5,100 feet above sea level to 3,500 ft and primarily identifies basin fill materials above and of the lower Atrisco member formation and fault zones attributed to the rift valley. This report and map do not identify potential oil and gas productions zones.

The map was updated by Connell in 2006 and provided greater depth interpretation of the Middle Rio Grande Basin geology (Appendix A). Of significance are the cross sections provided. Cross section A-A' intersects the Middle Rio Grande Basin near the town of Bernalillo from west to east. This cross section shows projected geologic depths from surface elevations to more than 2.5 miles below mean sea level. It identifies fault zones created by the Rio Grande Rift grabens, shows the different valley fills (T8-Santa Fe Group), the deeper Mesozoic sedimentary rocks (Mz-see Oil and Gas Resources below), the Paleozoic sedimentary rocks (Pz) at depth and the top formation of the Sandia mountains on the east, and finally the basement rocks of the rift, the Proterozoic rocks of the Sandia mountains. Of interest are the shallower depths of the T8 group and the Mz group. Cross section B-B' intersects the Rio Grande rift on the northern area of the City of Albuquerque from west to east. This cross section also identifies fault zones and shows the greater depth of the valley fill material (T8) in the Rio Grande Valley and the Mesozoic sedimentary rocks. This cross section shows projected depths of 4.3 miles below mean sea level. The third cross

section C-C' is from west to east primarily following I-40 showing the extended depth of the valley fill along with faulting. This section's Y-axis is significantly shallower from surface elevation to mean sea level.

The Geology of the Bernalillo and Placitas quadrangles, Sandoval County by [Connell](#) in 1998 and revised in 2000 provides additional cross sections and is presented in Appendix A. As stated in Plate 1:

“A geologic map graphically displays information on the distribution, nature, orientation and age relationships of rock and surficial units and the occurrence of structural features. These data are derived from geologic field mapping, compilation of published and unpublished work, analyses of borehole geophysics and well-cuttings, and photogeologic interpretation. Locations of geologic unit contacts are not surveyed; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist(s). Portions of the study area were mapped at scales larger than depicted on the geologic map; therefore, the user should be aware of significant variations in map detail.”

Cross sections of the area are presented in Plate 2-1 with map unit descriptions in Plate 2a and 3. Cross section A-A' in Plate 1a and 2-1 bisects the Rio Grande rift similarly to Connell's updated work in preliminary geologic map of the Albuquerque West Quadrangle and provides greater detail of geologic units. The depths are from approximately 6,000 feet above mean sea level to 10,000 feet below mean sea level, and major faults are identified and named throughout the basin. Of significance for this guidance are the Cretaceous formations presented in green (Kmf, Km_u, Km_l). These formations are deepest towards the middle of the basin and shallowest towards the east where down-drop blocks are less. As discussed below in oil and gas resources, these formations have the best potential for oil and gas production. As with other cross sections, this shows the geologic complexity of the rift.

The Geology of Alameda quadrangle, Bernalillo and Sandoval Counties and accompanying report, also by Connell in 1997 and revised in 2000 (Appendix A) provides additional geologic descriptions primarily on Albuquerque's northeast area with cross sections from surface elevation to 1,000 feet above mean sea level. It identifies the Rincon and Sandia faults as major range-bounding structures by normal, west slip faulting associated with the rift. The cross sections show primarily quaternary deposits above and below the Atrisco member unit along with the East Heights Fault zone with formations east of the Eubank and Alameda strand fault dominated by piedmont deposits.

The Geology of Dalies quadrangle, Bernalillo and Valencia Counties in 1998 and revised in 2000 provides surface geology and focuses on the west side of Los Lunas with emphasis on the Volcanic rocks of Cat Hills. The Geologic Map of the Tome quadrangle, Valencia County by Rawlings and McCraw from 2004 focuses on the middle of the basin near and south of Tome towards the east. Cross section A-A' in this quadrangle begins at surface elevation and projects to depths of 3,000 feet below mean sea level. Faults typical to the graben system of the rift are identified and deposits are primarily quaternary fluvial deposits (Upper Sierra Ladrones Formation) and middle and lower Santa Fe Group deposits to unknown depths. The Geologic map of the Tome NE quadrangle, Valencia County also by Rawling and McCraw in 2004 begins on the west in the Santa Fe Group deposits (QTsu). The draft Geologic Map of the Belen 7.5 minute Quadrangle by Rawling in 2003 provides a relatively

shallow cross section of the quarternary upper Santa Fe Group. These maps are also provided in Appendix ?

Oil and Gas Resources

Oil and gas production is significant to New Mexico as a whole. The Oil Conservation Division (OCD) of the State Energy, Minerals and Natural Resources Department provides an interactive [GIS map](#) that displays oil and gas wells in New Mexico. This map provides details of active, new, plugged, cancelled, and temporarily abandoned wells throughout the state. This map identifies locations, status, and findings for all oil and gas wells drilled within the MRGB and MRCOG boundaries. Please reference this map for well information within the members' jurisdiction.

Oil and Gas potential in the MRGB

Numerous research projects and papers have been published on the potential of oil and gas production within the MRGB. In short, the reports indicate that gas shows have been reported in the Cretaceous strata but at low economic viability primarily due to depth and low strata permeability. Nevertheless, gas is present in these strata. The following excerpts are taken from Ron Broadhead (New Mexico Bureau of Geology and Mineral Resources) [Oil and Natural Gas Potential of the Albuquerque Basin](#):

“Beneath the Tertiary sediments lies a thick section of Cretaceous strata (as much as 5,000 feet thick) that is broadly similar in character to Cretaceous strata that are prolifically productive of natural gas in the San Juan Basin of north-western New Mexico.

In deeper parts of the basin, the organic-rich Cretaceous shales have been cooked sufficiently to have yielded the maximum amount of oil and gas possible given their organic content.

During the 1970s and early 1980s the first sustained oil and natural gas exploration effort began in the basin. During this period, Shell Oil Company conducted extensive seismic reflection surveys and drilled seven unsuccessful deep (and expensive) exploratory wells, several of which encountered non-commercial volumes or ‘shows’ of oil and natural gas. As expenses for the exploration program mounted without a return on investment, Shell partnered with other companies to drill an additional two wells. Natural gas was reportedly flowed and flared at the Shell No. 1 West Mesa Federal well, but large expenses associated with drilling this deep (19,375 feet) well, combined with the low price of natural gas and apparently limited flow rates, contributed to the non-commercial nature of the reservoir encountered by the well.”

The basin saw no further exploratory drilling until the post-Shell exploration phase began in 1995. In that year Davis Petroleum, in conjunction with Vastar Resources, drilled two exploratory wells. The first well was drilled near the northern end of the Albuquerque Basin. This well drilled the entire Cretaceous section but encountered only minor shows and was subsequently abandoned and converted to a water supply well.

The steep rise in natural gas prices over the past few years, plus improved exploration,

drilling, and completion technology, will enhance the economics of exploring for, drilling for, developing, and producing natural gas in a basin such as Albuquerque where the target reservoirs occur at depths of 15,000 to 20,000 feet or more over large parts of the basin.”

A report by Ronald Johnson, Thomas M. Finn and Vito F. Nuccio published by USGS in 2001 entitled “Potential for Basin-Centered Gas Accumulation in the Albuquerque Basin” presents that Cretaceous source rocks are generating gas. The following excerpts are taken from this [report](#):

“The potential that a basin-centered or continuous-type gas accumulation is present in the Albuquerque Basin in central New Mexico was investigated. The Albuquerque Basin is one of the many rift basins that make up the Rio Grand Rift system, an area of active extension from Oligocene to recent time. The basin is significantly different from other Rocky Mountain basins that contain basin-centered gas accumulations because it is actively subsiding and is at near maximum burial and heating conditions at the present time. Burial reconstructions suggest that Cretaceous-age source rocks began to generate gas in the deeper parts of the basin about 20 million years ago and are still generating large amounts of gas. The high mud weights typically used while drilling the Cretaceous interval in the deeper areas of the basin suggest some degree of over-pressuring. Gas shows are commonly reported while drilling through the Cretaceous interval; however, attempts to complete gas wells in the Cretaceous have resulted in subeconomic quantities of gas, primarily because of low permeabilities. Little water has been reported. All of these characteristics suggest that a basin-centered gas accumulation of some sort is present in the Albuquerque Basin.”

A report commissioned by the Bureau of Land Management in 2010 entitled “[Mineral Resources Potential and Reasonable Foreseeable Development for Planning Units 1-5: Final Report](#)” identifies levels of resource potential as high (H), moderate (M) or low (L). In addition the report further defines levels of certainty as A (insufficient evidence), B (indirect evidence), C (direct evidence), and D (abundant direct and indirect evidence). A location designation of H and D would indicate high potential for oil and gas with abundant evidence. In contrast, a location designation of L and A would have a low potential for oil and gas with insufficient evidence. The following excerpt of the report for the Albuquerque Basin state:

“The oil and gas potential in the Albuquerque basin is judged to be low, with a direct evidence level of certainty (L,C). Exploratory drilling to date has encountered oil and gas shows, but no commercial production, according to available data. The sporadic nature of exploration in this region is reflected on the point density mineral potential map (Plate 55), which indicates low resource potential along the western edge of the basin.”

In June 2018, the New Mexico Bureau of Geology and Mineral Resources submitted a [report](#) to the Sandoval County Planning and Zoning Commission. This report by Ronald Broadhead and Alex J. Rinehart is entitled “The Oil and Natural Gas Potential of Sandoval County, New Mexico, and its Relationship to Groundwater, With a Discussion of Modern Oil Drilling Methods and Possibilities for Aquifer Contamination.” Supplements to this report were provided in [October](#) and [November](#) 2018. In general, these reports indicate where oil and gas may be potentially found within the MRGB. The following excerpts from the report indicate:

“As one moves to the south and southeast (from the southeastern flank of the San Juan Basin), burial depths of source-rock bearing strata become shallower and thermally maturity of the source rocks decreases. As the divide (or transition) between the San Juan and Albuquerque Basins is reached, source rocks in the Cretaceous and Jurassic sections have become progressively less mature and oil and natural gas potential becomes correspondingly low.

As a result, Cretaceous strata, which are the principal oil and gas productive strata in the San Juan Basin, are deepest along the central axis of the basin and shallowest in the shallower fault blocks along the eastern and western basin margins.

The Mancos C, which is the main target for drilling in northwestern Sandoval County, is thermally immature where it has been preserved in the shallow fault blocks on the eastern and western flanks of the Sandoval County part of the basin. It has not generated oil in these areas and will be nonproductive. Further towards the center of the basin where it has been buried more deeply, the Mancos C has been matured to the uppermost part of the oil window and is in the early stages of oil generation. The Mancos C production will be less than optimal and thermal maturity levels suggest that it may be comparable to Mancos C production at the southeastern limit of production in the San Juan Basin where the Mancos C has also been matured to the uppermost part of the oil window. In a narrow area along the basin axis, which is roughly coincident with the Rio Grande, the Mancos C is buried more deeply and has been matured to the lower part of the oil window or perhaps even into the thermogenic gas window.

Perhaps an optimal target for oil exploration in the Sandoval County part of the Albuquerque Basin is the Jurassic Entrada Sandstone. The Entrada is present at greater depths than the Mancos. The Todilto limestones, which are the source rocks for oil reservoirs in the Entrada, are thermally more mature than the Mancos and approach optimum thermal maturity. The Entrada is a conventional oil reservoir that is highly porous and permeable. Deeper targets in Triassic, Permian and Pennsylvanian strata within the Albuquerque Basin are likely to be barren of oil and gas. Although they are thermally mature, there do not appear to be any appreciable volumes of petroleum source rocks present within these strata. Therefore, no oil or gas has been generated and none will be present (Broadhead et.al., 2018).”

Drill and O&G Production Techniques

Water is associated with oil and gas production in four ways: 1) during drilling; 2) to improve production of a completed well (stimulation); 3) for secondary and enhanced oil recovery; and 4) water recovered from the well along with oil and gas which is commonly referred to as produced water.

Water Use and Fracking

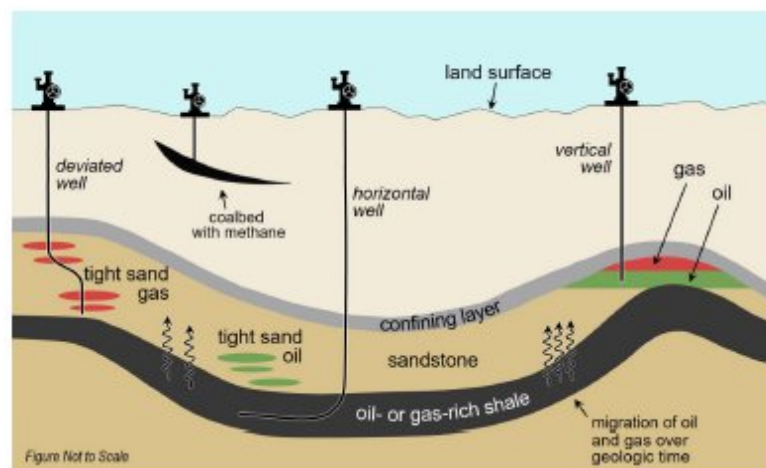
Water for Drilling: Virtually all oil & gas wells are now constructed using a variation of the rotary drilling method in which a rotating bit at the end of a long string of drill pipe grinds through the rock to reach the target oil & gas formation (Azar and Samuel, 2007). A fluid is pumped down the hole to stabilize the drill hole, lubricate and cool the drill bit, and to carry cuttings back to the surface. This fluid may consist of air for shallow wells (< 3,000 ft) but most oil & gas wells use a water or oil-based fluid such as diesel oil. Bentonite or other clay

is often added to the fluid to increase its density and to seal the walls of the hole to prevent loss of water into the formation, thus, the fluids are referred to as “drilling muds.” Other additives to drilling muds may include organics such as starch or lignosulfonates; chemicals to limit flocculation of mud, such as phosphates; and chemicals to increase the density of the mud, such as barite (BaSO_4).

Clean drilling mud is pumped down the hole, accumulates drill cuttings and then returns to the surface. It flows into a mud pit which allows the cuttings to settle and is then recycled back down the hole. Because the drilling fluid is recycled only a small amount is required for each hole. Accordingly, water requirements for drilling are small.

Traditional oil & gas wells were vertical wells. However, in the last 30 years, increasingly wells are drilled using directional drilling technology. In particular, horizontal wells allow petroleum engineers to drill laterally for many thousands of feet to precisely locate the well in the best position to maximize hydrocarbon recovery. An illustration of the different types of oil & gas reservoirs that may be encountered and the type of well used to recover the resource is presented in Figure 2.

Figure 2. Conceptual illustration of the types of oil and gas reservoirs and production wells used in hydraulic fracturing (EPA, 2016)



Water for Stimulation: Once a well has been drilled it must be prepared for production. This starts by removing all of the drilling mud and is usually followed by modifying the strata around the well to improve flow of oil & gas to the well and is referred to as stimulation. Stimulation may be accomplished by injecting chemicals such as acids to increase the porosity of the nearby rock, or a chemical dispersant to decrease the viscosity of the oil. Most commonly though, stimulation involves hydraulic fracturing, which means s injecting a fluid into the rock surrounding the well under sufficient pressure to cause it to fracture. Chemicals and sand are added to the fluid to improve the performance of the process. Hydraulic fracturing is commonly referred to as “fracking.”

Fracking has been used to improve productivity of water, oil, and gas wells for many decades. The cause for new concern regarding the process is the extensive use of horizontal drilling and fracking to develop tight sand and shale deposits that could not otherwise produce economic quantities of oil & gas. By combining these two technologies, the U.S. has become one of the world's leading oil & gas producing countries (EIA, 2019).

There are a number of concerns that have been raised regarding fracking. These include: 1) large amounts of water used for fracking; 2) contamination from fracking chemicals; 3) contamination of overlying and nearby aquifers by the fracking process; 4) increased earthquake risk from fracking; and 5) management of wastewater from the fracking process. A large amount of information about all aspects of fracking is available from the website "[FracFocus](#)" maintained by the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission (GWPC and IOGCC, 2019).

Volumes of water used for fracking: The Oil Conservation Commission (OCD) of the New Mexico Energy and Minerals Department (EMNRD) requires drillers to report the volume of water used for fracking to FracFocus. This data shows that, depending on the formation, a well might use up to 30 barrels (bbl or 1,300 gallons) per foot of length for a fracturing job (Scanlon et al., 2017). Thus, a 10,000 ft well might use 300,000 bbl (12.6 Million gallon or 38 acre-ft) of water. Data reported to FracFocus show that in 2018, 554 wells were fracked in NM and used a total of 13,000 acre-ft (4.2 Billion gallons) of water. In the past, all water used for fracking was fresh water, and a cottage industry developed in the oil & gas regions of the state in which owners of irrigation and private domestic wells would sell water to the industry. However, increasingly industry is turning to use of produced water for fracking because it's cheaper, often closer to the drill site, and similarities between the chemistry of the produced water and formation to be fracked result in higher productivity of the well. Unfortunately, the data in the FracFocus database does not distinguish between fresh and produced water used for fracking. The EPA (2016, Chapter 10) states that 30 to 80% of water used for fracking is produced water.

Though 13,000 acre-ft of water is a large volume it must be considered in comparison to the total water demand in the oil & gas regions of the state. The total volume of water used for irrigation by agricultural interests in Lea and Eddy counties, the two major oil counties located in the Permian Basin of southeastern NM, was 427,800 acre-ft of water in 2010 (Longworth et al., 2013). Thus, water used for fracking in the entire state amounted to about 3% of the water used for irrigated agriculture in Lea and Eddy counties.

Fracking Chemicals: Originally the industry considered chemicals used for fracking to be proprietary, however, OCD now requires that all chemicals used in a fracturing job be reported to FracFocus (GWPC and IOGCC, 2019). A summary of the classes of chemicals used and their function is listed in Table 1. A list of the most common chemicals is included as an Appendix.

Table 1. Types of chemicals used in hydraulic fracturing (GWPC and IOGCC, 2019).

Additive	Purpose	Downhole Result
Acid	Helps dissolve minerals and initiate cracks in the rock	Reacts with minerals present in the formation to create salts, water, and carbon dioxide (neutralized)
Acid/Corrosion Inhibitor	Protects casing from corrosion	Bonds to metal surfaces (pipe) downhole. Any remaining product not bonded is broken down by micro-organisms and consumed or returned in produced water.
Biocide	Eliminates bacteria in the water that can cause corrosive by products	Reacts with micro-organisms that may be present in the treatment fluid and formation. These micro-organisms break down the product with a small amount of the product returning in produced water.
Base Carrier Fluid (water)	Create Fracture Geometry and Suspend Proppant	Some stays in formation while remainder returns with natural formation water as "produced water" (actual amounts returned vary from well to well)
Breaker	Allows a delayed break down of gels when required.	Reacts with the "crosslinker" and "gel" once in the formation making it easier for the fluid to flow to the borehole. Reaction produces ammonia and sulfate salts which are returned in produced water.
Clay and Shale Stabilization/control	Temporary or Permanent Clay Stabilizer to lock down clays in the shale structure	Reacts with clays in the formation through a sodium - potassium ion exchange. Reaction results in sodium chloride (table salt) which is returned in produced water. Also replaces binder salts like Calcium Chloride helping to keep the formation in tact as the Calcium Chloride dissolves.
Crosslinker	Maintains viscosity as temperature increases	Combines with the "breaker" in the formation to create salts that are returned in produced water
Friction Reducer	Reduces Friction effects over base water in pipe	Remains in the formation where temperature and exposure to the "breaker" allows it to be broken down and consumed by naturally occurring micro-organisms. A small amount returns with produced water.
Gel	Thickens the water in order to suspend the proppant	Combines with the "breaker" in the formation thus making it much easier for the fluid to flow to the borehole and return in produced water
Iron Control	Iron chelating agent that helps prevent precipitation of metal oxides	Reacts with minerals in the formation to create simple salts, carbon dioxide and water all of which are returned in produced water
Non-Emulsifier	Used to break or separate oil / water mixtures (emulsions)	Generally returned with produced water, but in some formations may enter the gas stream and return in the produced natural gas.
pH Adjusting Agent/Buffer	maintains the effectiveness of other additives such as crosslinkers	Reacts with acidic agents in the treatment fluid to maintain a neutral (non-acidic, non-alkaline) pH. Reaction results in mineral salts, water and carbon dioxide which is returned in produced water.
Propping Agent	Keeps Fractures Open allowing for hydrocarbon production	Stays in formation, embedded in fractures (used to "prop" fractures open)
Scale Inhibitor	Prevent Scale in Pipe and Formation	Product attaches to the formation downhole. The majority of product returns with produced water while remaining reacts with microorganisms that break down and consume the product.
Surfactant	Reduce Surface tension of the treatment fluid in the formation and helps improve fluid recovery from the well after the frac is completed	Some surfactants are made to react with the formation, some are designed to be returned with produced water, or, in some formations they may enter the gas stream and return in the produced natural gas.

An EPA report ([2016, Chapter 9](#)) presents a lengthy discussion of the chemicals used in fracking and the risks they pose to human health. The report identified 1,606 chemicals that had been reported in either frack fluids or produced water, with 1,084 of which detected in frack fluids, and 599 having been detected in produced water. The chemicals used in frack fluids must be reported to the OCD, although the actual recipe of the formulation (i.e. the amounts or concentrations) is not. All chemicals that are added to frack fluids are required to have an OSHA approved Safety Data Sheet (SDS) . The SDS provides information on the chemical properties and potential hazards of each constituent used, as well as guidance for their safe handling.

The EPA analysis noted that detailed information on human health risk is available for less than 10% of the chemicals used in fracking and about 20% of the chemicals reported in produced water. However, the report also noted that this lack of detailed information, "is not unique to the hydraulic fracturing industry, as it has been estimated that there are tens of thousands of chemicals in commercial use that have not undergone significant toxicological evaluation" (EPA, 2016, Chapter 9). The report further noted that potential threats are likely to be local, as most of the chemicals are used in less than 1% of the wells nationally. While recognizing the lack of toxicologic data, the report also noted that the threat posed by chemicals in fracking fluid are primarily local and depend on the chemicals used, the hydrogeological conditions, and possible exposure pathways.

Management of Flowback and Produced Water from the Fracking Process:

As oil or gas is pumped from a production well it is accompanied by a large volume of water. Initially this water consists largely of flowback water from the fracking process but within a few weeks all of the water pumped to the surface is from the surrounding water. Because of the gradual shift from fracking water to formation water, and because over the life of the well the volume of formation water greatly exceeds that used for fracking, the two are considered together as produced water (PW) and are managed as such.

The ratio of the volume of PW produced per volume of oil or gas depends on a number of variables, principally the type of formation and the type of well. In the Permian Basin of southeastern NM, approximately 5 gallons of PW are produced for every gallon of oil (Zemlick et al., 2018). In the San Juan Basin, 0.02 gallon of PW is produced per barrel of oil equivalent (BOE) of natural gas (i.e. the amount of natural gas with the same energy as a gallon of oil which is 170 m³ of natural gas) (Zemlick et al., 2018). The total amount of PW produced in New Mexico in Lea and Eddy counties was 108,000 AF in 2016, two and a half times the typical annual consumptive use of water by customers of the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) (Zemlick et al., 2018), a very large amount of water to manage. This water is transported throughout the region via temporary and permanent pipelines and by trucks. Both present important infrastructure challenges to communities and the environment in oil and gas areas.

Figure 3. Photograph of temporary pipelines used to transport water in the Permian Basin (photo by Thomson, 2017).



In addition to the very large volume of PW produced annually, its management challenges are greatly complicated by its very poor quality. Produced water quality varies widely and depends both on the basin in which it is found but also varies from well to well within the basin. This complexity is compounded in formations such as the Permian Basin where eight oil bearing strata exist, each with different water quality. Because of this variability, it is not meaningful to cite average water quality characteristics, but a study by Chaudhary et al. (2016) determined that the average total dissolved solids (TDS) concentrations of PW of 136 g/L and 95 g/L were reported in the Delaware Basin and Central Basin Platform respectively, in southeastern NM. The TDS of seawater is 35 g/L for reference.

In addition to the extremely high salinity, the chemistry of PW makes it nearly impossible to desalinate. Whereas greater than 90% of the TDS in seawater is comprised of greater than 90% sodium and chloride, the TDS of PW contains large amounts of calcium (Ca²⁺) and sulfate (SO₄²⁻) in addition to sodium and chloride. These constituents form scale during desalination processes. Therefore, although a very large volume of PW is produced by oil and gas development, the combination of extremely high salinity and very high mineral scale

forming potential makes desalination and recovery of the water economically and probably technologically infeasible.

Current practice in NM is to manage PW through a combination of injection in deep Class II injection wells referred to as salt water disposal wells (SWD) and reuse of the water to achieve secondary recovery of oil (SRO). About half of PW in the Permian Basin is disposed of in SWD and the rest is used for SRO (Goetz, 2018). A very small fraction is also used for fracking, as industry has found that it is often cheaper and better results are obtained using PW instead of fresh water.

Although current practice is to dispose of PW in SWDs, the risk of induced seismicity associated with disposal of large volumes of this water has caused both regulators and the oil and gas industry to recognize that this method of disposal may be limited in the future. A further concern is that reuse of large volumes PW in SRO is less feasible in horizontal wells completed in tight formations because of the low permeability. This may further constrain PW disposal and reuse alternatives.

Water Resources

Considerable amount of scientific, technical, and investigative work have been published on the Middle Rio Grande Basin's water resources by multiple agencies, institutions, and individuals. The purpose of this guidance is to provide a summary of the current understanding of the water resources in the area.

Surface Water Resources

The Rio Grande has provided water for communities since human habitation of the area and was the primary source of water for residents. Prior to 1923, the river fluctuated depending on weather conditions leading to sedimentation, flooding, shallower groundwater, and wetlands. In 1923 the Middle Rio Grande Conservancy District was created to provide flood protections and irrigation water to farmlands. By the 1950's the Federal Bureau of Reclamation repaired many of the Conservancy's dams and channelized 127 miles of the river ([MRGCD](#), 2019). By 1975, the Army Corp of Engineers built Cochiti Reservoir as part of the Flood Control Act of 1960 (Paskus, 2013). The river's water had not been a primary source of drinking water until 2008 when the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) began using, treating, and distributing river water to the Albuquerque area through the San Juan Chama Drinking Water Project. The Colorado River Storage Project Act of 1956 provided 48,200 acre feet per year of surface water rights from the San Juan Chama project for Albuquerque's use in 1965 ([ABCWUA](#), 2016). Surface water usage in the MRGB is for irrigated agriculture and the San Juan Chama Drinking Water Project. Possible impacts to the Middle Rio Grande surface water from the oil and gas industry would primarily occur through spills and unauthorized discharges.

Groundwater Resources

Albuquerque drilled its first drinking water well in 1875 near Old Town. Until 2008 groundwater was the primary source of municipal drinking water. The ABCWUA has a network of 90 groundwater production wells (ABCWUA, 2016). As stated above, the majority of the Basin's water production is from the Santa Fe Group Aquifer formation and within the upper 2,000 feet of the aquifer. Prior to 1980, the conceptual model of the Middle Rio Grande Basin hydrogeologic framework was that there was a "subterranean equivalent of

a vast underground lake that would take centuries to exploit.” ([NMBGMR](#), 2019) Water level declines near Albuquerque’s Coronado Center lead to a reassessment of the Middle Rio Grande’s groundwater resources. The conceptual model was revised to the “zone of highly productive aquifer in the basin is much thinner and less extensive than had been previously reported.” ([NMBGMR](#), 2019)

The ABCWUA’s and other municipality’s sole use of groundwater as the drinking water source prior to 2008 caused a steady decline in water levels throughout the Basin. The USGS in cooperation with the City of Albuquerque and the Office of the State Engineer began a groundwater level monitoring program in 1996. Numerous piezometers throughout the region are monitored on a regular basis ([USGS](#), 2019). For instance, the Jerry Cline piezometer data shows seasonal variation of the depth to groundwater in 2004 ranging between approximately 442 to 451 feet below ground surface (bgs). In 2008 that range varied between approximately 404 to 410 feet bgs indicating an increase in water levels of approximately 40 feet ([USGS](#), 2019). This trend is evident in many of the piezometers as shown in the Nor Este Piezometer showing an increase in water level of approximately 45 feet in a similar timeframe ([USGS](#), 2019). The USGS further published potentiometric maps of the Santa Fe Group Aquifer System in [2008](#) and [2012](#) showing water level increases between these time periods. This along with the on-going monitoring program indicates that groundwater resources are not being depleted as previously.

The ABCWUA has outlined a plan called “Water 2120: Securing our Water Future” to ensure, in part, a sustainable water supply for the next 100 years. This plan shows anticipated future supply and demand, conservation, surface water usage, aquifer storage, and options to extend existing water supplies. Surface water is the primary water resource for Albuquerque and groundwater as the secondary source in times of surface water scarcity. Scenarios are presented in this plan that addresses a high demand and low supply to a low demand and high supply to meet Albuquerque’s long term water needs. Under the worse-case scenario additional water resources for Albuquerque’s residents would not be needed until 2060. The other scenarios indicate sufficient resources to keep the groundwater resource at or above a management level until 2120 (ABCWUA, 2016). The plan also addresses the potential use of brackish and produced water as a possible future resource.

In 2014 the City of Rio Rancho updated their Water Resource Management Plan (WRMP, 2014) as a programmatic and planning guide for water conservation and resources. Thirty-nine implementation policies were identified and re-prioritized to ensure a sustainable water supply. Rio Rancho’s major water resource demand is supplied by groundwater. Aquifer storage and recovery, reuse, and conservation programs are the focus of the 39 policies and are instrumental in meeting future water resource demands.

Brackish Water

Deep brackish groundwater in the Basin has been evaluated as a potential water resource by the ABCWUA and others (ABCWUA, 2016). Brackish water is described as having total dissolved solids (TDS) concentrations ranging between 1,000 to 10,000 milligrams per liter or parts per million (ppm). Saline water has TDS concentrations ranging between 10,000 and 35,000 ppm ([New Mexico Earth Matters](#), 2015).

A study conducted for the ABCWUA in 2013 identified the potential for deep brackish groundwater as a resource in the Albuquerque area. Five brackish water aquifers were

described for the Basin. Deep aquifers on the west mesa below the Santa Fe Group in the Jurassic aquifer below late Cretaceous formations may range from depths between 8,000 and 32,000 feet with TDS concentration around 21,000 ppm. The northern part of the Basin near Bernalillo in this same deep aquifer had depths around 7,500 feet with a TDS ranging from 5,000 to 11,000 ppm. The deeper still Permian aged aquifer also in the northern part of the basin has TDS concentrations of 3,000 ppm but with elevated temperatures ranging from 276 to 316 °F. The deep Lower Santa Fe Group aquifer with very large thicknesses is likely to contain very saline water due to the long residence time with depth. The Mesa del Sol deep aquifers also in the Jurassic and Permian formations at depths from 7,200 to 14,500 feet are believed to contain highly brackish waters. The Santa Fe Group aquifer in the southwestern part of the Basin has saturated thicknesses ranging from 5,000 to over 8,000 feet with TDS values near 3,500 ppm. Brackish water from bedrock units further to the west may be contributing to the Santa Fe Group in this area. Upward leakage into the Santa Fe Group from deep bedrock aquifers at depths around 8,000 feet may be contributing saline water (Shomaker, 2013).

Overview of Brackish Water Resources in New Mexico indicates that the Santa Fe Group aquifer system ranges in thickness from 2,400 feet to around 14,000 feet in the center of the Basin and water is assumed to be of poor quality at depth (Land, 2016).

Concerns during oil and gas development and production, especially through horizontal drilling and fracking, are that deep brackish or saline water may transport upward impacting usable groundwater resources. A study conducted in 2013 focused on the fluid mixing and salinization due to fault inputs in an intersection of the Albuquerque and Socorro basins or the Middle Rio Grande Basin known as the Socorro constriction. The study indicated that deep aquifers from older sedimentary geologic formations upwell at the southern end of the Basin. The study's hydrologic model indicates that faults near the rift margins may allow for the movement upwards of deeper brackish waters into the unconfined Santa Fe Group (Williams, et.al, 2013).

Regulatory Authority

Regulatory authority for oil and gas production on tribal, federal, and state lands is not within the purview of local ordinances. Rather, it lies with the respective responsible agencies and departments consistent with federal and state regulations and policies. Many of those govern regulations, however, are also applicable and take precedence over local ordinances that may be enacted for lands under local jurisdiction.

Federal Acts and Provisions

In preparation of a proposed Oil and Gas Ordinance, Sandoval County developed an extensive list of applicable federal and state regulatory citations. Federal regulations that may address environmental and community regulations affecting oil and gas activities, and be further amplified or enforced through state level regulations, include:

- The Emergency Planning and Community Right to Know Act, 42 U.S.C.A §§11001
- Federal Water Pollution Control Act (Clean Water Act) 33 U.S.C. 1251-1376
- The Clean Air Act 42 U.S.C 42 U.S.C.A §7401
- The Energy Policy Act, 42 U.S.C.A §6201

- The Occupational Safety and Health Act 1970, U.S.C.A §651 et. seq.

There are also federal regulations that address protection of tribal and cultural properties and communities. Many of these are the basis for further state regulations, and many may be incorporated in whole or in part into existing local zoning and process requirements. These pertain to a wide range of activities, and are not necessarily limited to oil and gas related activities.

- The National Historic Preservation Act, N.M.S.A, 16 U.S.C.A. 42 U.S.C.A §§470 et. Seq.
- The American Indian Religious Freedom Act, 42 U.S.C ch 21 sub ch I. §§1996 & 1996a
- The Native American Grave Protection and Repatriation Act 25 U.S.C. ch 32 §3001 et. seq.
- The Archeological Resources Protection Act, 16. U.S.C.A. 470aa et. seq.

State Acts and Provisions

The potential for state preemption of local ordinances would lie within a variety of State of New Mexico Regulations as outlined in the following New Mexico State Statutes. Those directly pertaining to the oil and gas activities include:

- The Oil and Gas Act NMSA. 1978 §§70-2
- The Surface Owners Protection Action NMSA. 1978 §§70-12-1
- Water Quality Act (NMSA 1978, Chapter 74-6)
- The New Mexico Air Quality Control Act – NMSA 1978-2

Stemming from the authorizations under the Oil and Gas Act (N.M.S.A.. 1978 §§70-2-2), the State of New Mexico regulates specific oil and gas activities through the Oil Conservation Commission (OCC) and establishes the regulatory duties of the Oil Conservation Division within the New Mexico Department of Energy, Minerals, and Natural Resources Division. The duties and powers given are for “jurisdiction and authority over all matters relating to *the conservation of oil and gas*... . It shall have jurisdiction, authority and control of and overall persons, matters or things necessary or proper to enforce effectively the provision of this act or any other law of this state *relating to the conservation of oil or gas*... .”

While *conservation* is not defined, *waste* of the resource is prohibited and is *underground waste* is defined as “inefficient, excessive or improper, use or dissipation of the reservoir energy...”and “...the location, spacing, drilling, equipping, operating or producing, of any well or wells in a manner to reduce or tend to reduce the total quantity of crude petroleum oil or natural gas ultimately recovered...”. *Surface waste* is defined as well as “the unnecessary or excessive surface loss or destruction without beneficial use, however caused, of natural gas of any type or in any form or crude petroleum oil, or any product thereof, but including the loss or destruction, without beneficial use, resulting from evaporation, seepage, leakage or fire.....”. The OCD rules and regulations designed to prevent such wastes are provided in

New Mexico Administrative Code, Title 19 Natural Resources and Environment, Chapter 15 Oil and Gas (NMAC, 19:15:1-112).

Oil and Gas Act

The 112 chapters of that code deal with procedural and surface and subsurface operation and well and environmental protection issues. Table ?, following, provides a quick cross reference to those chapters that address existing state process, requirements, and the status of state's extent of "occupying the field".

Under the existing OCD rules and framework, applications to drill offer an opportunity for addressing many of the public concerns raised about oil and gas development – such as whether drilling should be allowed, where drilling may occur and how drilling operations should be conducted. However, those rules do not require or provide for public hearings prior to the issuance of a drilling permit, and are usually issued administratively.

Table 2. Summary of NMAC Title 19 Chapter 15 Of Interest for Local Oil and Gas Ordinance Provisions

Section Reference (NMAC 19.15.xx)	Title	Relevance and Short Summary
1 and 2	General Provisions for Oil and Gas Operations	Definitions used in state regulations. Operating principle of preventing "contamination of fresh water" or allowing gas to "leak or escape ... from wells, tanks, containers, pipe, or other storage, conduit or operating equipment. Fresh water includes all lakes and playas, , surface waters, and underground waters containing 10,0000 mg/L or less of TDS
3	Rulemaking	Rule making process and hearing participation. 19.15.3.8 "Any person may file an application with the commission to adopt, amend, or repeal any rule within the commission's jurisdiction"
4	Adjudications	Not Relevant
5	Enforcement and Compliance	19.5.5.9 Definition of operator compliance, including sliding scale of number of wells out of compliance based on number of wells operated and required posting of status of operators financial assurance status and violations and penalties issued
6	Tax Incentives	Not Relevant
7	Forms and Reports	Types of forms, reports and applications currently required by the state. Of particular interest for local ordinance would be: C-101 Application for permit to drill, deepen or plug back

		<p>C-102 Well location and acreage dedication plat</p> <p>C-103 Sundry notices and reports on wells</p> <p>C-104 Request for allowable and authorization to transport</p> <p>C-105 Well completion or re-completion report and log</p> <p>C-107 Application for multiple completions</p> <p>C-108 Application to dispose of salt water by injection</p> <p>C-117-A Tank cleaning, sediment oil removal, transportation</p> <p>C-117-B Monthly sediment oil disposal statement</p> <p>C-120-A Monthly water disposal report</p> <p>C-122- G Worksheet for calculation of static column pressure</p> <p>C-129 Application for exception to no-flare</p> <p>C-137 Application for waste management facility</p> <p>C-137- EZ Registration/final closure report for small landfarm</p> <p>C-138 Request for approval to accept solid waste</p> <p>C-141 Release notification and corrective action</p> <p>C-144 Pit, closed loop system alternative method permit or closure plan application</p> <p>C-145 Change of operator</p> <p>C-146 Change of operator name</p>
8	Financial Assurance	<p>State financial guarantees, forms of assurance, additional requirements for plugging insurance policies</p> <p>19.15.8.9 C, D and 19.15.8.15</p> <p>One of the following for Active Wells</p> <p>1 well \$25,000 plus \$2 per foot vertical depth including horizontal wells or</p> <p>Or, blanket plugging assurance for all active wells:</p> <ul style="list-style-type: none"> • \$50,000 for 1 to 10 wells • \$75,000 for 11 to 50 wells • \$125,000 for 51 to 100 wells • \$250,000 for more than 100 wells

		<p>One of the following for Inactive wells (temporarily abandoned for more than two years)</p> <p>1 well \$25,000 plus \$2 per foot vertical depth including horizontal wells</p> <p>Or, blanket plugging assurance for all inactive wells:</p> <ul style="list-style-type: none"> • \$150,000 for 1 to 5 wells • \$300,000 for 6 to 10 wells • \$500,000 for 11 to 25 wells • \$1,000,000 for more than 25 wells
9	Well Operator Provisions	Registration requirements and owner and operator changes.
10	Safety	Minimal specified requirements: oil wells to be cleaned into a pit, flowing wells produce through and oil and gas separator, ignition sources not less than 150 feet, remove rubbish or debris to a distance of at least 150 feet from wells and tanks and burn or dispose of waste to avoid creating a fire hazard, control bottom hole pressures, test blowout preventers once every 24 hours.
11	Hydrogen Sulfide Gas	Relevance is basin dependent. Probably not the purview of local ordinance.
12 and 13	Pools and Compulsory Pooling	Not Relevant
14	Drilling Permits	Permits required, mineral owner or working interest owner consent required, operator must be in compliance, special provision for horizontal well per 19.15.16.15
15	Well Spacing and Location	Not Relevant : minimal well spacings as set by State
16	Drilling and Production	<p>Well signage, casing and cementing requirements.</p> <p>19.15.16.19, “<i>shall ensure fresh water and waters of present or probable value for domestic, commercial or stock purposes ... are adequately protected by division-approved methods.</i>” Horizontal well provisions mostly dealing with spacing requirements. 19.15.16.17 Five day notification requirement if fracturing damages the formation.</p> <p>19.15.16.19 B Hydraulic fracturing disclosure to FracFocus within 45 days after completion, re-completion, or other hydraulic fracturing treatment of the well – all information</p>

		as required by the Frac Focus form, limited to SDS information, allows for proprietary information exclusion, .
17	Pits, Closed-Loop systems,, Below Grade Tanks and Pumps	Definitions of types of system and full list of setback requirements from various water sources and features depending on feature type, pit type and expected fluid concentrations. <i>Location prohibited within “incorporated municipal boundaries or within a defined municipal wellfield covered under a municipal ordinance adopted pursuant to NMSA 1978 3-27-3 as amended, unless municipality specifically approves.</i> Operational requirements, and closure requirements for soils and for waste left in place are provided and based on depth to fresh water. Process for variances
18 through 24	Various production practices, proration, off lease transport, and sale and take provisions	Not Generally Relevant. 19.15.18.16 General requirements and signage for dikes, fire walls, and required use of same for given set backs
25	Plugging and Abandonment of Wells	9.15.25.8 Permanent or temporary abandonment required within 90 days following: a 60-days following suspension of drilling operations, no longer usable for beneficial purposes, or one year in which a well has been continuously inactive.
26	Injection	Permit for injection required, use of produced water disposal wells. Testing, monitoring, and pressure increase requests.
27-28	(Reserved)	Not Relevant
29	Releases	Notification and reporting requirements for major (25 barrels or more or greater than 500 Million Cubic Feet (MCF), or reasonable probability to reach water course or endanger public health, or substantially damages property or the environment) and minor releases (greater than 5 barrels or 50 MCF). Includes site assessment and characterization requirements as detailed in the regulation. Requirements for more stringent requirements if release is in area where groundwater is less than 50 feet, and based on with various setbacks (including 1,000 feet of any fresh water well or spring). Closure criteria specified for various contaminant sources.
30	Remediation	Addresses contamination in subsurface water with concentrations of less than 10,000 mg/L TDS as well as surface waters. Abatement plan proposals. Standards are set at 20.6.2.3103 NMAC and no toxic pollutants as defined

		in 20.6.2.7 NMAC present.
31-33	(Reserved)	Not Relevant
34	Produced Water, Drilling Fluids, and Liquid Oil Field Waste	Requirements for dispositions, by reuse, recycling facility, or disposal. Siting requirements for recycling facilities containment and closure requirements for the same.
35	Waste Disposal	Disposal of certain waste at solid waste facility allowed and may be allowed with division approval for other types of wastes. Provisions for disposal of NORM in wells to be plugged and abandoned or via injection.
36	Surface Waste Management Facilities	Requirements for surface waste management facilities, including permit, siting, and design requirements, and including financial assurance requirements and closure and post closure care requirements.
37 through 106	Refining, special rules, Various Specification and Standards, and (Reserved 41-102)	Not Relevant
107	Administrative Penalties	Provides for penalties and assessment of severity and offense. Penalties are minimal, and range from 0 to no more than \$1,000. 12 month rolling record for determining first offense
108 through 112	Various weighing and measuring, biodiesel and E85 requirements, , retail natural gas provisions.	Not Relevant

Surface Owners Protection Act (NMSA 1978 Ch 70 Section 12)

The Surface Owners Protection Act outlines the obligations that an oil and gas operator owes to the surface land owner. This includes compensations for damages sustained by the surface owners, for loss of agricultural production and income, loss of land values, lost use and loss access to the land, and lost value of improvements. However, the payments only cover land

affected by the oil and gas operations. It also requires reclamation of the land surface affected the operator's oil and gas operations.

Preliminary entry onto the surface for no disruptive activities require the operator to provide five days' notice to the surface owner. A thirty day notice is required prior to entry to conduct oil and gas operations. That thirty day notice also requires a proposed surface use and compensation agreement that addresses a wide variety of issues including: placement of well pads, gathering pipelines and roads; construction and maintenance of all pits and equipment; use and impoundment of water; surface water drainage changes; control and management of noise, weeds, dust, traffic, trespass, and litter; and operator indemnification, and an offer of compensation for damages.

The surface owner may then accept or reject the proposed offer within twenty days. If rejected, the surface owner may then enter into negotiations, which may include provisions for binding arbitrations or mediation. If after thirty days from the date of notice no agreement has been reached, the operator may still enter the surface owner's property and conduct oil and gas operations. This "right of entry" is contingent on the operator depositing a surety bond or letter of credit in the amount of \$10,000 per well location, or posting a blanket surety bond or letter of credit of \$25,000. The operator is then also subject to any Court finding of damages for entry without agreement or having placed a bond, and for any actions not in compliance with any surface agreement that might have been in place.

Water Quality Act (NMSA 1978, Chapter 74-6))

The Water Quality Control Commission (WQCC) was created under the provisions of the Water Quality Act (NMSA 1978 74-6-3). The delegation of duties to constituent agencies, such as the NMED, whose secretary serves on the WQCC, is allowed by provisions of that Water Quality Act (NMSA 1978, Section 74-6-4.F. and 74-6-8). Many of the provisions and functions of the Water Quality Act are administered and regulated through the NMED.

However, the chairman of the OCC (or designee) holds a seat on the WQCC, which then makes the OCC/OCD a constituent agency. Accordingly, the OCD is given responsibility for administration and enforcement of the Water Quality Act as it pertains to oil and gas activities including: surface and groundwater discharges at oil and natural gas production sites, oil refineries, natural gas processing plants, carbon dioxide facilities, natural gas transmission lines, and discharges associated with activities of the oil field service industry (EMNRD, 2008 p.9), including primacy for administering and regulating Class II injection wells. The Class II injection wells are used to inject oil and gas production wastes and materials, including produced water from production operations.

NMSA 1978 70-2-12 (B) (21) specifies that OCD is to regulate the disposition of non-domestic wastes resulting from the exploration, development, production or storage of crude oil or natural gas to protect public health and the environment. NMSA 1978-2-12(B)(22) more specifically provides that the OCD regulate disposition of non-domestic wastes originating from the oil field service industry, the transportation of crude oil or natural gas, the treatment of natural gas or the refinement of crude oil to protect public health and the environment, including administering the Water Quality Act. The OCD administers the

WQCC Regulations pertaining to oil and gas as provided in NMAC 20.6.2 (discharges, disposals, closure) and NMAC 20.6.4 (standards for interstate and intrastate surface waters) (EMNRD, 2008).

Beginning in 1961, the duties of the OCD/OCC expanded from oil and gas conservation into areas of environmental protection, specifically the disposition of water produced or used in connection with drilling and “in a manner that will afford reasonable protection against contamination of fresh water supplies designated by the State Engineer”. In 1978, environmental protection duties were further expanded to include regulation of the disposition of non-domestic oil field wastes “to protect public health and the environment”. In 1996, the duties regarding plugging abandoned wells to include the duties “to restore and remediate abandoned well sites and associated production facilities. In more recent years, the OCC/OCD enacted rules covering enforcement and financial assurances for well plugging (2005), new surface waste management rules (2007), and new rules and restriction on the use of various pits and below surface holding tanks (2008). (EMNRD, 2008)

The OCD provides the oil and gas industry with written guidance on how best to prevent environmental pollution in its *Pollution Prevention Best Management Practices* manual (2000), *Pollution Prevention Pocket Guide* (1999), and the *Environmental Handbook* (contains various guidelines and standards of varying dates and currency). These guides are provided at the OCD website: www.emnrd.state.nm.us/ocd.

The existing rules which provide environmental protections under the Water Quality Act are briefly summarized in Table 1, and include NMAC 19:15. Section 16 deals with drilling operations, Section 17 (known as the “pit rules”) addresses the use of pits, as well as allowable residual soil concentrations following reclamation, and Section 25 addresses plugging and abandonment. Reporting of release and remediation requirements, including soil residual standards, are provided in NMAC 19:15 Sections 29 and 30, and are dependent on depth to shallowest groundwater with less than 10,000 mg/L total dissolved solids.

New Mexico Air Quality Control Act (NMSA 1978 Chapter 74 Part 2) / Clean Air Act

The OCC/OCD has the statutory authority to regulate oil and gas activities to protect water and disposition of oil and gas related wastes to “protect health and the environment” (EMNRD 2008, p.13). The existing statutory authority does not specifically extend to air pollution issues. The OCC/OCD could, but has not, used the regulatory definition of “oil field waste” to provide for rulemaking and permitting process to address oil and gas air pollution, such as methane leaks.

Rather, NMED regulates oil and gas air pollution under the Air Quality Control Act (AQCA – NMSA 1978, 74-2), which in many ways is limited or “preempted” by the federal Clean Air Act (or federal act). The AQCA authorizes the Environmental Improvement Board (EIB) to adopt regulations to prevent or abate ambient (outdoor) air quality impacts from industrial sources. However, the NMED must exercise its authority within the scope of the AQCA and the EIB adopted regulations. In some instances, such as for Bernalillo County and the City of Albuquerque, a county or municipality may assume jurisdiction as a local authority by adopting an ordinance providing for local administration and enforcement of the Act

(EMNRD 2008, p. 34). However, the enabling legislation (NMSA 1978, 74-2-4 (D)) explicitly retains jurisdiction of the AQCA for the EIB with respect for the local board's act or failure to act.

The duties of the EIB and/or its designated local board, and constraints on their duties and powers, are provided in NMSA 1978 74-2-5 (C). In particular, visibility standards and standards of performance for sources and for emission standards for hazardous air pollutants shall be:

no more stringent, but at least as stringent as required by the federal act and federal regulations, and

applicable only to sources subject to such regulation pursuant to the federal act.

Emissions from solid waste incinerators can be regulated more stringently than applicable federal limitations as can emissions related to ozone attainment. This explicit limiting of state and local standards to "no more than the federal standards" is a clear use of "preemption" to which local ordinances must yield.

The EIB is also constrained by the AQCA from applying the "precautionary principle" to deny an air quality permit for a project. The allowed bases for denying an air quality permit are specified in NMSA 1978 74-2-7 and do not include the precautionary principle as a basis for decision. The "precautionary principle" has been described as follows:

When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process to apply the precautionary principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternative, including no action.

Likewise, the NMED is also barred by provisions of the AQCA from considering environmental issues other than air quality in deliberations on an air quality permit decision. Similarly, the EIB is also barred by the AQCA from adopting emission limitations for well-site equipment more stringent than the federal standards of performance. Because of the enabling legislation, local boards must operate in a similar manner. The basis for denial of permits must be a demonstrated inability to meet the specified standards of the AQCA or the federal act, or attainment of related standards or limitations. Similarly the NMED or local board can only impose such conditions as are needed to ensure that such standards or limitations are achieved.

Currently, the EIB requires industrial sources with greater than 10 pounds per hours or 25 tons per year of any regulated air pollutant to obtain a permit. If the sources exceed 100 tons per year of any regulated pollutant and exceed 240 tons per year of any regulated pollutant, a federal air permit is required. The NMED has the existing authority to require

a single-state minor source construction permit for drilling operations in the same basin and which are owned and operated by a single company. If the aggregate emission would cause or contribute exceedance of a state or federal ambient air quality standard, or violate a federal standard of performance, then a source permit could be denied. However, individual wells, such as would be drilled during the exploratory phase within the Middle Rio Grande Basin, typically fall below the threshold for air quality permits.

In Bernalillo County and within the City of Albuquerque, the responsibility for air pollution regulation has been delegated to the joint Albuquerque-Bernalillo County Air Quality Control Board (AQCB) (Bernalillo County Code, Chapter 30, Section 30-32) and as discussed above are similarly constrained by the preemption of the federal act (Bernalillo County Code, Chapter 30, Section 30-33). However, the local board may require “any person emitting any air contaminant” to install, use, and maintain emission monitoring devices and to sample emissions in accordance with methods, locations, and intervals as may be prescribed by the board. Additionally, in making its local regulations, the local board may in fact, give weight to the character and degree of injury to or interference with health, welfare, visibility and property; the public interest including the social and economic value of the sources and subjects of air contaminants, and ethical practicability and economic reasonableness of reducing or eliminating air contaminants.

This local monitoring and weighting allowance is likely an extension of the provisions of NMSA 1978 74-2-5-1 (G) which allows that the local board (as well as the NMED) may “classify and record air contaminant sources that, in its judgment, may cause or contribute to air pollutions...” and which contains similar language with “special reference on health, economic and social factors and physical effects on property:...”. The local boards and agencies may also “develop and present to the environmental improvement board or the local board a plan for regulation, control, prevention or abatement of air pollution...”.

Because of the AQCA explicit recognition of preemption by the federal act (Clean Air Act), federal action regarding methane emissions related to oil and gas activities directly impacts NMED’s and the the local board’s (ABCAQCB) abilities to address methane as an air contaminant. While the local board may be able to find that methane is a potential air contaminant, and impose additional local monitoring requirements, such rules would only apply to non-federal and tribal lands within the limits of Bernalillo County. The local board could not impose standards more stringent than federal requirements unless specifically intended to address federally-established visibility or ozone standards. Other Middle Rio Grande Basin entities would continue to rely on state enforcement and regulations, which in turn are preempted by the federal act and related limitations and standards.

Clean Air Act / Federal Methane Rules

In May 2016, the USEPA issued three final rules that were intended to curb methane emissions (a component of natural gas) by 40 to 45 percent from 2012 levels by 2025, along with emissions of smog-forming volatile organic compounds (VOCs) and toxic air pollutants such as benzene. (USEPA Fact Sheet: EPA’s Actions to Reduce Methane Emissions from the Oil and Natural Gas Industry: Final Rules and Draft Information Collection Request). The rules were to apply to new, reconstructed and modified oil and gas sources, and to

provide greater certainty about the Clean Air Act permitting process. The three rules included:

- Updates to the new Source Performance Standards (NSPS) that would curb emissions of methane and VOCs from new and modified sources in the oil and gas industry
 - Applied to natural gas well sites, oil well sites, gas production gathering and boosting stations, gas processing plants, and natural gas transmission compressor stations
 - Built on the USEPAs 2012 rules to curb VOC emissions
 - Required low production wells to monitor leaks, rather than exempting them as initially proposed
 - Set a fixed schedule for monitoring leaks rather than a variable schedule based on performance
 - requires compressor stations to monitor leaks four times a year, rather than twice a year
 - requires leak monitoring twice a year for well sites
 - allowed for alternative approaches for finding leaks using portable VOC monitoring in addition to optical gas imaging
 - Added regulatory coverage for additional equipment and activities in the oil and gas production chain including pneumatic pumps at well sites and gas processing plants, and compressors and pneumatic controllers at transmission and storage facilities
 - Set emission limits for methane
 - Required owners/operators to find and repair leaks (or fugitive emissions)
 - Phased in requirements for use of “green completion” techniques to capture emission from hydraulically fractured oil wells.
 - Allowed states to continue regulating air pollution from the oil and gas industry so long as the requirements are at least protective as federal requirements (*whereas New Mexico self-limits requirements to be “no more stringent” than the federal requirements*)
 - Issued an Information Collection Request for information pertaining to existing sources.
- the Source Determination Rule that would clarify EPA’s air permitting rules as the applied to the oil and natural gas industry
 - clarified when multiple pieces of equipment and activities in the oil and gas industry must be deemed a single source when determining whether major source permitting programs apply
 - Clarification of the term “adjacent” as it applies to that determination of a major source
- the Federal Implementation Plan for EPA’s Indian Country Minor New Source Review (NSR) program for oil and gas production in Indian country
 - *these rules are not within the purview of local ordinance jurisdictions.*

Following the change in administrations, in September 2018 the EPA proposed “targeted improvements” to the 2016 NSPS for the oil and gas industry with the intent to streamline

implementation, reduce duplicative EPA and state requirements, and significantly decrease unnecessary burdens on domestic energy producers. (USEPA Fact Sheet: EPA Proposes Amendments to the 2106 New Source Performance Standards for the Oil and Natural Gas Industry: Fact Sheet). Proposed changes to the 2016 NSPS rules include:

- Changes to fugitive emission requirements, to include:
 - Modifying the schedule for monitoring at both well sites and compressor stations along with the schedule for making repairs, including biennial monitoring at low production wells, and annual monitoring at other well sites (rather than twice per year)
 - Allowing monitoring to be halted once all major production and processing equipment is removed so that the site contains only well heads, while separate tank batteries would remain subject to monitoring requirements.
 - Allowing monitoring at compressor stations to be reduced from quarterly to semi-annual or annually.
 - Allowing owners/operators to apply to conduct the monitoring using emerging technologies and requirements to do so
 - Expanding the time to complete leak repairs from 30 days to 60 days
- Establishing alternative fugitive emission standards based on requirements established by certain states.
 - USEPA determined that in the 2016 rule it had been unable to conclude that any state or local program for addressing fugitive emissions could be deemed to be “at least equivalent” to the NSPS.
 - USEPA, upon further review, determined that several state programs are “at least equivalent to the fugitive emissions monitoring, repair and recordkeeping requirements included in the 2018 proposed rule and would allow owner/operators to use such state requirements as alternative standards.”
- Amending the requirement for profession engineer certification of technical infeasibility (and allowing in-house engineer with appropriate expertise) of routing from a pneumatic pump to a control device or process and to extend that exemption to include all well sites (not just for greenfield well sites).
- Amending the Alternative Means of Emissions Limitation (AMEL) to allow collaborative efforts of owner/operators, manufacturers, vendors, or trade associations to apply for an AMEL that incorporates emerging technologies.

The 2018 revision of the standards is ongoing. The process for determining equivalency for component emission standards and the evaluation for each of the states reviewed is documented in an EPA Memorandum of April 12, 2018 (USEPA Memorandum, 2018).

Reviewing the New Mexico standards to those of the proposed federal standards, the EPA makes the following statement in its memorandum:

5.6 New Mexico

Title 19, Chapter 15, Part 2 of the New Mexico Administrative Code (NMAC) prevents production operators from allowing gas to “either leak or escape from ... wells, tanks, containers, pipe or other storage, conduit, or operating equipment.” 21 However, we were unable to determine how these requirements are enforced. Therefore, we are not able to evaluate equivalency of these requirements to the 2018 Proposal.

To emphasize, the EPA could not determine from state regulations how the existing Oil and Gas Act provisions related to air pollution are enforced.

The enforcement mechanisms lie with the NMED, or perhaps the OCD if it should chose to act in that realm, or in the case of Bernalillo County / City of Albuquerque jurisdictional areas (and where there is no existing oil or gas production. Because of the AQCA limitations imposing a cap of federal standards and limits on state agencies, the NMED and local boards are not allowed to utilize surrounding state emission standard and regulations (such as Colorado or Texas), which have been shown to be “at least equivalent” to the federal standards.

Water Law and Role of the Office of the State Engineer (OSE)

Water is used extensively in association with many oil and gas activities, including but not limited to use as a supplemental fluid in enhanced recover of petroleum resources, for hydrostatic testing, and in the process of hydraulic fracturing. Hydraulic fracturing consists of pumping into the formation large volumes of water that generally has been treated with a friction reducer, surfactant and clay stabilizers, and sand (used as a propping agent). In developed fields, most of the water used in association with oil and gas production is “produced water”, which is produced as a byproduct in the drilling and production of oil and/or gas. Produced water is not administered by the Office of the State Engineer, but disposition is regulated by the OCD to ensure reasonable protection against contamination of fresh water supplies (NMSA 1978 70-2-12 (B)(15). (EMNRD 2008, p. 43)

The OSE assists the OCD with fresh water protection by providing technical information and specialized hydrologic expertise. Additionally, a person intending to drill a well to appropriate nonpotable ($>1,000$ mg/l TDS) from an aquifer at a depth of 2,500 feet or more is required to file notice with the OSE (NMSA 1978 72-12-26), and such waters are administered by the OSE NMSA 1978, 72-12-25 through 28). Specifically, oil and gas exploration and production are subject to such requirements. Any person may file in district court for damages or for injunctive relief with respect to any claimed impairment of existing water rights due to an appropriation of nonpotable water.

Temporary uses of fresh water supplies for oil and gas drilling operations is allowed by the OSE under provisions of NMSA 1978 72-12-1.3. Such uses are not to exceed three acre-feet for a definite period of time not to exceed one year for drilling operations designed to discover or develop the natural mineral resources of the state. The OSE examines the filed application regarding the facts and, if the proposed use will not permanently impair any existing rights of others, the OSE shall grant the application. If the OSE finds that permanent impairment may occur, the application is then advertised and hearings held as described under NMSA 1978 72-12-3. Other appropriations (i.e. not temporary use) require an application to appropriate (NMSA 1978 72-12-3(A). If the well is located on private land not owned by the applicant, then the application must include an acknowledged statement that the applicant is granted access across the owner’s land as is necessary to drill and operate the

well. *(This is separate from the Surface Owner's Protection Act which allows for legal entry over surface owner's objections for the purpose of exercising mineral rights ownership).*

Additional State Acts and Regulations:

Other related state “environmental” acts may affect the administration of the Oil and Gas Act, but are administered by varying state agencies as listed below:

- The Uniform Trade Secret Act, NMSA. 1978 §§57-3A-1 et Seq.
 - (Construction Industries Division, but Disclosure requirements for fluids are addressed by the OCD)
- The New Mexico Night Sky Protection Act N.M.S.A. 1978 74-12-1 through 72-12-11
 - (Regulation and Licensing Department: Construction Industries Division)
- The Rangeland Protection Act, NMSA. 1978 §§76-7B-1 et seq
 - (Department of Agriculture)
- The Wildlife Conservation Act, NMSA. 1978 §§17-2-37 et. seq.
 - (Department of Game and Fish)
- The New Mexico Public Health Act, NMSA. 1978 §§24-1-1
 - (Department of Health)

Those pertaining to tribal, and cultural properties and communities protection include:

- The Cultural Properties Act, NMSA. 1978 §§18-6-1
- The Cultural Properties Protection Act, NMSA. 1978 §§18-6A-1 et. seq.
- The Prehistoric and Historic Sites Act, NMSA. 1978 §§18-8-1

Under NMSA 1978 9-21-7 – the Indian Affairs Department Act - the Indian Affairs Department is the coordinating agency for intergovernmental and interagency programs concerning tribal governments and the state. It is charged with assisting in setting policy and acting as a clearinghouse for all state programs affecting the Indian people of New Mexico. This works in consult with the other cultural properties acts and historic sites acts, which are overseen by the Department of Cultural Affairs, and the by the Cultural Properties Review Committee - one member of which is a member of a New Mexico Indian nation, tribe or pueblo.

Regulatory Purview of Municipalities and Counties

The legislative and quasi-judicial allowances to and duties of municipalities and counties are addressed in NMSA 1978 Chapter 3 Municipalities, Chapter 4 Counties, and Chapter 5 Municipalities and Counties. Table ? provides a summary of the various NMSA statutes that may provide Municipalities and Counties regulatory leeway to propose and implement ordinances related to oil and gas activities. Though the NMSA, there is strong legal precedence for local governments to engage in all manner or rule making regarding public safety concerns, land use, and nuisance issues related to lights and noise.

Table 3. Summary of NMAC Title 19 Chapter 15 Of Interest for Local Oil and Gas Ordinance

Section Reference	Title	Relevance and Short Summary

(NMSA 1978 xx.xx)		
3-1-2	Definitions	<p>Municipal defined to include any incorporated city, town or village, incorporated counties, and H class counties</p> <p>Municipal utility defined to include sewer, water, gas, electric, and generating facilities or any interest in jointly owned generating facilities owned by a municipality and serving the public.</p>
3-2-1	Petition to incorporate	<p>Includes a list of services typically provided by a municipality. Ordinances stemming from those services are a reasonable extension of a municipalities “police powers”, and include: law enforcement, fire protection and safety, road and street construction and maintenance, water supply or distribution or both, wastewater treatment, stormwater collection and disposal; electric or gas utility services, enforcement of building, housing, plumbing, and electrical codes or other similar codes, planning and zoning.</p>
3-17-1	Ordinances; Purposes	<p>The governing body may adopt ordinance or resolutions not inconsistent with the laws of New Mexico for the purposes of:</p> <ul style="list-style-type: none"> • Effecting or discharging the powers and duties conferred; • Providing for the safety, preserving the health, promoting the prosperity and improving the morals, order, comfort and convenience of the municipality and its inhabitants; and • Enforcing obedience to the ordinance by prosecution in the municipal and metropolitan courts. <p>Fines may not be more than \$500 or imprisonment for not more than ninety days or both, and for violations of an industrial user wastewater pretreatment ordinance, a fine of not more than one \$1,000/day for each violation.</p>
3-17-7	Water Conservation	<p>Municipalities shall consider ordinance and codes to encourage water conservation and drought management – <i>This provision may be applicable to addressing water use by oil and gas activities.</i></p>
3-18-1	General powers	<p>A municipality may protect the property of its municipality and its inhabitants, preserve peace and order with the municipality, and establish rates for serviced provided by municipal utilities and revenue-producing projects.</p>
3-18-5	Dangerous buildings	<p>Municipalities may determine and require the removal of any building or structure which is ruined, damaged and dilapidated, or covered with ruins, rubbish, wreckage or</p>

		<p>debris.</p> <p><i>This may assist with addressing abandoned or dilapidated wells, well pads, or other oil and gas related structures and requiring financial assurances for ensuring such removal.</i></p>
3-18-6	Fire zones	Municipalities within it planning and platting jurisdiction prescribed standards for regulating the construction of partition fences and party wells; and establish fire zones and prohibit construction of structures that do not meet fire resistance ratings or standards established for each zone.
3-18-7	Additional powers: flood hazard areas, flood plain permits, land use control; jurisdiction	Municipalities may prescribe standards for buildings and other improvements under a permit system within a designated flood or mudslide hazard area, require development review by the local flood plain manager for development.
3-18-11	Fire prevention and protection	A municipality may adopt regulations for the prevention of fire, regulate and prevent the carrying on of manufactories dangerous in causing and promoting fires, regulate and prevent the storage and transportation of any combustible or explosive material, as well as provide proper means for protection from fire.
3-18-17	Nuisances	Municipalities may define a nuisance, abate a nuisance, and impose penalties upon a person who creates or allows and nuisance to exist, and may prohibit and suppress, riots, noises, disturbances , or disorderly assemblies in any public or private place .
3-21-1	Zoning	<p>In general, zoning is the purview of municipalities and local governments. The authority is given for the purpose of promoting health, safety, morals or the general welfare. This includes issues regarding</p> <ul style="list-style-type: none"> • height, number of stories, and size of buildings and other structures, • percentage of a lot that may be occupied, • size of yards, courts, and other open space, • density of population, and • location and use of buildings, structures and land for trade industry, residence, or other purposes.
3-21-5	Zoning; conformance to comprehensive	<p>Regulations and restrictions of the county or municipal zoning authority are to be in accordance with a comprehensive plan and shall be designed to</p> <ul style="list-style-type: none"> • Lessen congestions in the streets and public ways

	plan	<ul style="list-style-type: none"> ● Secure safety from fire, flood waters, panic and other dangers, ● Promote health and general welfare, ● Provide adequate light and air, ● Prevent the overcrowding of land, ● Avoid undue concentration of population ● Facilitate adequate provision for transportation, water, sewerage, schools, parks, and other public requirements, ● Control and abate the unsightly use of buildings and land
3-21-11	Conflicts between regulations	<p>If other statute, regulation, or other local ordinance, resolution, or regulation the governing provisions shall be that which requires;</p> <p>“... or imposes, other higher standards.”</p>
3-21-12	Contracts	A county zoning authority may contract for staff assistance of a private planning agency or other various state and federal agencies.
3-21-13	Zoning enforcement by counties	Counties are extended the authority to regulate zoning under Sections 3-21-1 through 3-21-174. Fines are limited to \$300 or imprisonment for ninety days or both.
3-22	Historic Districts and Landmarks	Counties and municipalities are empowered to preserve, protect and enhance the historic areas and landmarks lying within their respective jurisdictions as constrained by the United States and State of New Mexico constitutions. The power includes the designation of regulation of historic zoning districts.
3-38	Licenses and Taxes	Allows for requirement for local licensing of businesses, including a separate license for each place of business conducted by the same person, firm, corporation or association. The fee shall bear a reasonable relation to the regulation of the business.
3-53-1	Waters: Regulation of use	<p>A municipality may perform a limited number of functions related to watercourses, ponds, wells and cisterns including:</p> <p>Drain or fill ponds on private property to prevent or abates nuisances; construct, repair and regulate the use of vaults, cisterns, hydrants, pumps, bridges viaducts, tunnels and wells; and regulate and authorize the construction of any ditch carrying water on, through, or across any street.</p>
3-53-2.1	Water resources	For the purposes of preserving and protecting water resources and to provide an assured water supply for the community, a county or municipality may require

		<ul style="list-style-type: none"> • Site development standards to conserve water and minimize water loss, • Water harvesting and storage • Low water use landscaping and plant materials • Nonagricultural residential and commercial water use limitations; • Recycling and reuse of water <p>Consistent with the state engineers rules, with agricultural water users or agricultural water rights owners being excluded.</p>
3-56-5	Regional planning; powers and duties	A regional planning commission may be used to prepare studies of the region's resources, both natural and human, with respect to existing and emerging problems of industry, commerce, transportation, population, housing , agriculture, public service, local governments and any other matters relevant to regional planning
4-36-5	Firefighting	Counties may contract for purchase of firefighting services, when in the opinion of the board of commissioners, such services may be more economically provided by such contracts than maintaining firefighting service by the county.
4-37-1	County Ordinances	Counties granted same powers as municipalities except where specifically limited. This includes power necessary and proper to provide for the safety, preserve the health, promote the prosperity, and improve the morals, order, comfort and convenience of the county or its inhabitants..
4-37-2	Areas in which County ordinance are effective	County ordinances are effective within the boundaries of the county, including privately owned land or land owned by the United States . However, ordinance are not effective within the limits of any incorporated municipality.
4-37-3	County enforcement	<p>County ordinance may be enforced in any court of competent jurisdiction of the county.</p> <p>Fines limited to no more than \$300 or ninety days imprisonment or both except no more than \$1000 for discarding or disposing of refuse, litter, or garbage of public or private property and no more than \$5,000 for improper or illegal disposal of hazardous waste.</p>
4-37-9.1	Water conservation and drought management	A county shall consider ordinances and codes to encourage water conservation and drought management planning.
4-57-1	County	Counties may establish County Planning Commissions with

	Planning Commission	the purpose of guiding and accomplishing a coordinated, adjusted and harmonious develop of the county which will, in accordance with existing and future needs, best promote health, safety, morals, order, convenience, prosperity or the general welfare as well as efficiency and economy in the process of development
5-8	Land Development Fees	No municipality or county may enact or impose a fee unless otherwise specifically authorized by the Development Fees Act. These would include impact fees for constructing capital improvement and facility expansions

Noise pollution is regulated by the NMED under the Environmental Improvement Act (NMSA 1978 74-1-7), but may also be the appropriate subject of municipal or county ordinance (NMSA 1978 3-18-17 and 4-37-1).

Similarly, light pollution (i.e. night sky protections) are also addressed in the Environmental Improvement Act (NMSA 1978 74-12-1 through 7). The Night Sky Protection Act requires that outdoor light fixtures be shielded except for incandescent fixture of one hundred fifty watts or less or other sources of seventy watts or less. Under state regulation, the fine for a second offense is \$25.00 minus the replacement cost for each offending fixture. However, NMSA 1978 74-12-7A provides for various exemptions including “(4) outdoor lighting fixtures that are necessary for worker safety at farms, ranches, dairies, feedlots or industrial, mining or oil and gas facilities”. Furthermore, the state requirements are “cumulative and supplemental” and “shall not apply within any county or municipality that, by ordinance or resolution, has adopted provisions restricting light pollution that are equal to or more stringent than the provisions of the Night Sky Protection Act (NMSA 1978 74-12-7B).

Summary of Expert and Community Concerns

Resources for the Future (RFF) is an independent, nonprofit research institution in Washington DC that has studied oil and gas impacts on communities and the status of oil and gas regulations extensively. The RFF was founded in 1952 by presidential commission to study the nation’ natural resource needs. It is funded from individual and corporation contributions, foundation and government grants, and investment income. Supporters include a variety of private foundations, energy sector corporations (including oil and gas), universities, and U.S. governmental agencies. RFF stated mission is “to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement ([Resources for the Future https://www.rff.org](https://www.rff.org)).

Summary of Expert Survey

RFF’s Center for Energy Economic and Policy (Krupnick et al, 2013) published the results of a survey-based, statistical analysis of experts in government, universities, oil and gas industry, and nongovernmental organizations (NGOs). The survey was intended to identify the priority environmental risks related to shale gas development for which government regulation or voluntary practices were inadequate to protect the public or the environment

(Krupnick et al, 2013, p.1). The survey participants are confidential, but the NGOs reportedly included all the major national environmental groups as well as some local and specialized groups concerned about particular issues. Among academics, all universities with a significant presence in the shale gas debate were also represented, as are at least one respondent from each of the key federal agencies, and about half of the states with shale gas resources. There was about a 30 percent participation rate in the survey. (Krupnick et al, 2013, p. 10).

The survey initially identified 265 potential exposure pathways and concerns for ranking by the participants. The average number of priority risk pathways was 55 and the median number was 39. Industry and government experts averaged 39 and 40 priorities, and academic experts averaged 54. The NGO respondents averaged 150 priorities, with a median of 100. The authors surmise that the reasons explaining the NGO response are: they see more pathways as having a higher risk than the other groups, they may have a lower-level of acceptable risk than the experts in other groups, and they may have perceptions that the benefits of shale gas extraction are low.

Based on the initial results, the authors then proceeded to rank and compare to determine “consensus” issues, by looking at the top 10, 20, and 40 ranked pathways from each group (i.e. Venn diagramming to determine overlaps in ranked priorities). Based on that analysis, the top 20 routine pathways were matrixed and from that 12 consensus routine risk pathways agreed upon by all expert groups were identified (Krupnick et al., 2013, pp 10-19). Table 4 from Krupnick et al, (2013, p.20) is reproduced below to show an abbreviated matrix of the pathway evaluations and identifying the 12 consensus concerns (shaded in green), as well as the degree of consensus of the various issues. The matrix is provided in Table 4.

As stated by Krupnick et al (2013, p.18), “Despite significant public and regulatory concerns about groundwater risks, risks to surface water were a dominant concern among the experts. Similarly both the air quality pathway concerns involve methane (which has implications for climate change), rather than conventional local air pollutants (such as nitrogen dioxide). The threat of habitat fragmentation from shale gas development infrastructure is also a consensus risk pathway, despite (or possibly because of) its relatively low profile in the public debate.”

Table 4 - Oil and Gas Risk Pathway Matrix (from Krupnick et al., 2013)

Activities	Intermediate impacts					Totals*
Site development & drilling preparation	Groundwater	Surface water	Air quality	Habitat disruption	Community disruption	2-0-0-2/18
Clearing of land/construction of roads, well pads, pipelines, other infrastructure		Stormwater flows		Habitat fragmentation	Industrial landscape(A)	2-0-0-1/9
On-road vehicle activity					Road congestion(I)	0-0-0-1/5
Drilling activities	Groundwater	Surface water	Air	Habitat	Community	1-2-3-7/45
Drilling equipment operation at surface	Drilling fluids and cuttings(G)	Drilling fluids & cuttings(A,G)			Noise pollution(I)	0-0-1-2/7
Drilling of vertical & lateral wellbore	Intrusion of saline-formation water(G)					0-0-0-1/5
Casing and cementing	Methane(I,A,G)					0-1-0-1/6
	Intrusion of saline-formation water(I)					
On-road & off-road vehicle activity					Road congestion(I)	0-0-0-1/5
Use of surface water & groundwater	Freshwater withdrawals(A)	Freshwater withdrawals(N)				0-0-0-2/5
Venting of methane			Methane			1-0-0-0/2
Storage of drilling fluids at surface		Drilling fluids & cuttings(A,G)				0-0-1-0/6
Disposal of drilling fluids, drill solids, cuttings	Drilling fluids and cuttings(N,A)	Drilling fluids & cuttings(N,I,A)				0-1-1-0/5
Fracturing & completion	Groundwater	Surface water	Air	Habitat	Community	4-1-1-2/62
Use of surface water & groundwater	Freshwater withdrawals	Freshwater withdrawals				2-0-0-0/5
Flowback of reservoir fluids	Flowback & produced water constituents(N,A)	Flowback & produced water constituents(N,I,A)				0-1-1-0/11
Venting of methane			Methane			1-0-0-0/2
Storage of fracturing fluids at drill site	Fracturing fluids(G)	Fracturing fluids				1-0-0-1/6
On-road & off-road vehicle activity					Road congestion(I)	0-0-0-1/7
Well production & operation	Groundwater	Surface water	Air	Habitat	Community	0-1-0-3/21
Well production	Flowback & produced water constituents(N)	Flowback & produced water constituents(N,A,G)				0-1-0-1/7
Condensate tank, dehydration unit operation			Volatile organic compounds(N)			0-0-0-1/7
Compressor operation			Conventional air pollutants & CO ₂ (N)			0-0-0-1/3
Fluid storage & disposal	Groundwater	Surface water	Air	Habitat	Community	5-1-2-4/80
On-site pit or pond storage	Flowback & produced water constituents	Flowback & produced water constituents	Volatile organic compounds(N)			3-0-0-2/11
	Fracturing fluids(G)	Fracturing fluids				
Transport off-site					Road congestion(I)	0-0-0-1/13
Treatment, release by industrial wastewater treatment plants		Flowback & produced water constituents				1-0-0-0/6
Treatment, release by municipal wastewater treatment plants		Flowback & produced water constituents				1-0-1-0/6
		Fracturing fluids(A,G)				
Deep underground injection	Flowback & produced water constituents(G)				Seismic vibrations(I,A)	0-0-1-1/6
Application of wastewater for road deicing, dust suppression		Flowback & produced water constituents(N,A,G)				0-1-0-0/11
Totals*	2-1-2-8 / 52	7-4-3-1 / 53	2-0-0-3 / 53	1-0-0-0 / 31	0-0-1-6 / 48	12-5-6-18/ 264

*Totals are: 4 agree-3agree-2agree-1agree/total pathways

Notes: Green = four in agreement, blue = three in agreement, yellow = two in agreement, white = one in agreement. (N) signifies NGO experts, (I) industry experts, (A) academic experts, and (G) government experts. Activities that have no pathways in any group's top 20 are omitted. No "soil quality" pathways or "other activity" pathways were in any group's top 20.

Overview of Community Concerns

Daniel Raimi is a senior research fellow at the RFF and author of *The Fracking Debate: the Risks, benefits, and Uncertainties of the Shale Revolution* (Raimi, 2018). The RFF has developed a series of issue briefs based on Raimi's work, which can be found at rff.org/publications/issue-briefs. The six issue briefs address concerns with the effect of tight oil and gas production on water quality, earthquakes, health impacts, local government, economic impacts, and climate change. The first four of the issues are relevant for consideration as a factor in developing a local oil and gas ordinance. Economic impacts are assessed at a regional scale and beyond the purview of these technical-based guidelines. The economic impacts may, however, be an appropriate consideration for discussions regarding "no net expense" to local government and a basis for consideration of approval/denial of a given plan or land use action. While important locally, climate change discussion is a national

energy policy decision and beyond the scope of the technical advisory group. It is not directly addressed within these guidelines, but is indirectly addressed through consideration of methane and volatile organic release as a local air quality/potential health concern.

Concerns with Water Quality Impacts (Surface Water, Produced Water Management, Groundwater Pathways, Water Use)

The initial request from the WPAB to the MRCOG was focused on the central issue of potential risk to groundwater quality from potential shale development activity.

There is a large and growing body of literature describing studies of the risk that fracking poses to overlying fresh water aquifers. Mechanisms by which ground water can be contaminated by fracking fluids or produced water include; spills and leaks from containment facilities at the surface, migration of fluids upward through underground fractures, and migration of fluid through the annular spacing of improperly sealed wells.

Spills and Releases

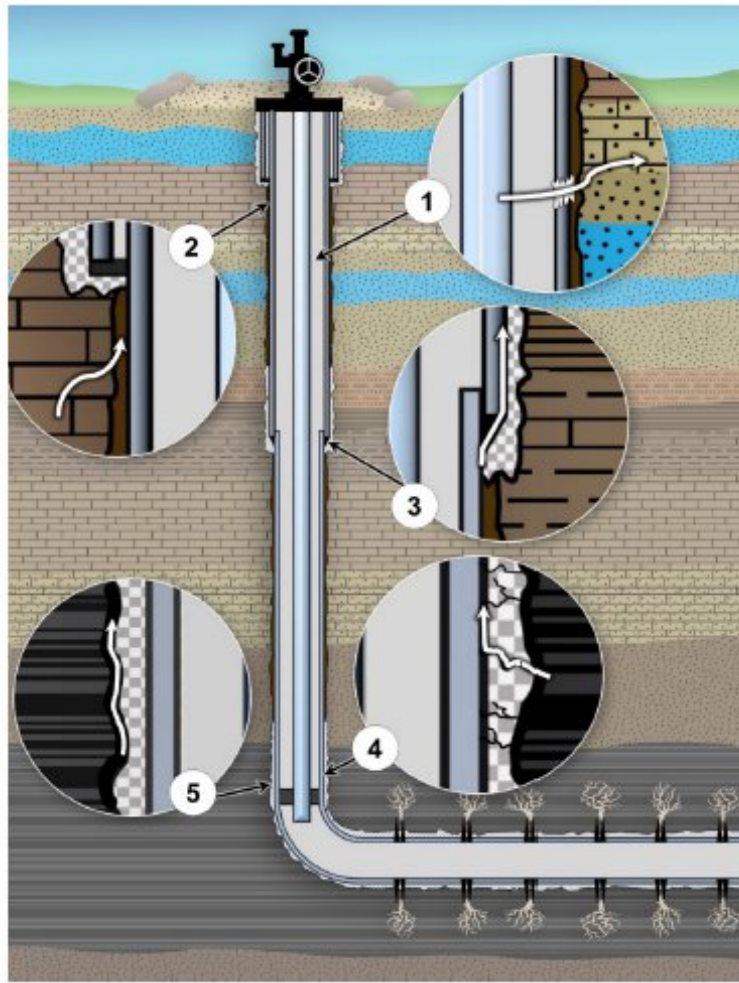
Fracking operations aside, related oil and gas activities such as use of unlined storage pits, improper wastewater disposal, and spills and releases have resulted in drinking water degradation, as is reflected by the expert consensus pathway identified previously. Spills of fracturing chemicals, oils or wastewater may occur due to human error or equipment failure at well sites, from pipelines, or from traffic accidents involving industry trucks. Of the 400 cases of groundwater contamination caused by oil and gas production activities occurring over decades in Texas and Ohio, an analysis of state records identified leaks and spills of oil and wastewater water (as opposed to injected fracking fluids) as the most common causes of contamination. (Raimi 2018, 18-06).

In NM, spills and releases of fluids must be reported to the OCD (NMAC 19.15.29) which maintains a data base of these events. Most involve small volumes of fluid, typically less than 1,000 gallons. Due to the remote location, large depth to groundwater, and lack of monitoring wells, it is not known how many, if any, have contaminated underlying ground water resources.

Subsurface Migration/Contamination Pathways

The EPA (2016) and other sources have noted that there is a risk of contamination of ground water resources posed by escape of frack fluids, produced water, and/or natural leakage from improperly constructed wells (Figure ?). The two most common problems are inadequate or degraded casing, or inadequate or degraded cement. In this case well fluids will move up through the casing or the cement grout by high pressure and escape through the casing or grout into overlying permeable aquifers. These risks can be mitigated by proper well design and construction. The importance of careful inspection during well construction is also noted. The integrity of the casing and cement can be confirmed by well logging and mechanical integrity testing after construction.

Figure 3. Potential pathways for fluid movement in a cemented wellbore (EPA, 2016).



Note: Pathways: 1) Leak through the well casing. 2) Migration along an uncemented annulus. 3) Migration along micro-annuli between the casing and cement. 4) Migration through poor cement. 5) Migration along micro-annuli between the cement and formation.

Stray gas migration (from casing or cemented annulus integrity issues rather than directly from the fracturing process) into nearby groundwater wells from oil and gas activities have, however infrequent, been documented with occurrence rates typically being less than 0.5 to 1% (Raimi 2018, Brief 18-06, p.2). This includes one case in Bradford County, Pennsylvania where stray gas entered the drinking water supply that is of particular note as a small amounts of a fracking geochemicals were also detected. Authors of the paper describing this incident hypothesize that there may have been a natural fracture between an uncased portion of the well (i.e. an uncased **vertical** portion) and a family's water supply. (Raimin, 2018, p.41). It should be noted that in many areas, such as the famous Weld County, Colorado flaming faucet documented in the *Gasland* film, methane is common and the presence of methane in most wells in the area is a naturally-occurring phenomena. (Raimi, 2018 p.40) and not related to oil and gas activities.

Staff with the NM OCD suspect that there may be a couple of instances in which frack fluids have migrated to the surface through interconnection between the fracked well and an

abandoned and improperly sealed nearby vertical well. This is a mechanism not mentioned by EPA, however, this migration pathway is only suspected and has not been confirmed. Regardless, this mechanism must be considered extremely rare given that there were 58,000 operating oil and gas wells in New Mexico in 2017 (EIA, 2018) and approximately as many abandoned wells.

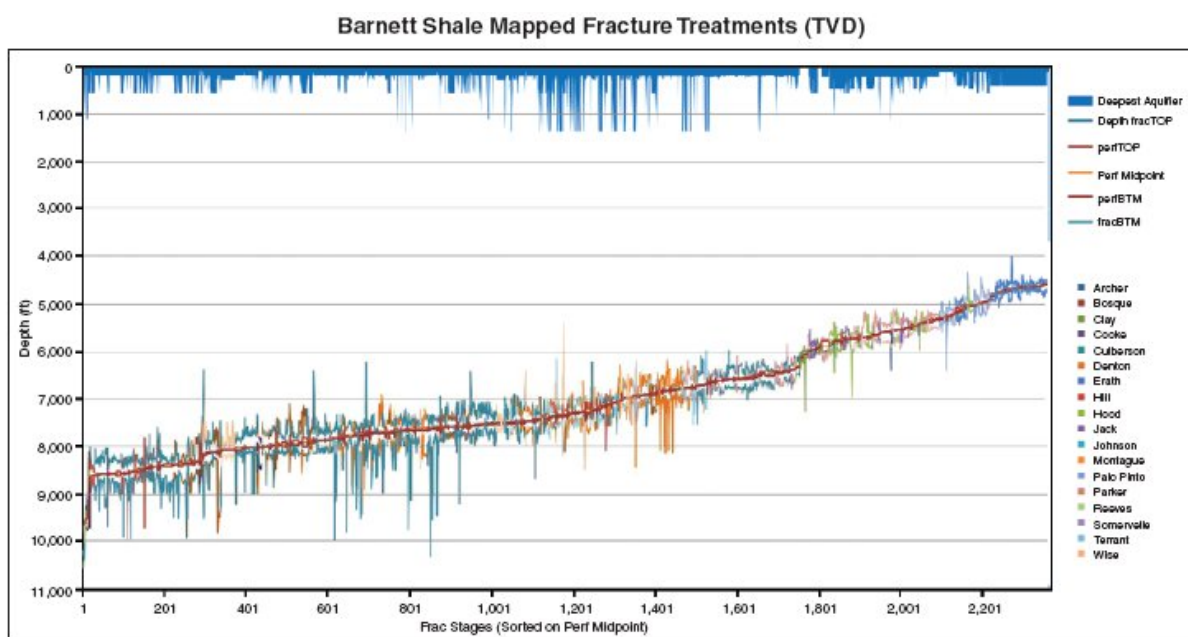
Groundwater contamination from oil and gas development generally falls under the jurisdiction of the OCD, though if fresh water aquifers are impacted, the Ground Water Quality Bureau (GWQB) of the NMED will become involved as well. Staff with the GWQB is not aware of any instances in which fresh water aquifers have been contaminated by fracking operations.

Pathways due to Formation Fracking

A common misconception is that fractures in the rock from the fracking operation extend upwards to overlying freshwater aquifers and create a path through which migration of frack fluids, produced water, and gas may contaminate the aquifer. Petroleum engineers and geophysicists use geophysical methods, especially micro-seismic and tilt-meters, to measure the fracture length from fracking (King, 2012). At depths less than about 2,000 foot, fractures are primarily oriented horizontally, whereas at deeper depths they are oriented vertically.

Flewelling et al. (2013) discuss the physical limitations on fracture heights and present data showing that fracture heights typically range from a few meters to roughly 100 meters. Fisher (2010) presented data collected by a fracking company from over 2,000 fracked wells in the Barnett Shale in central Texas which shows the length of fractures compared to the depth of water supply wells (5).

Figure 5. Mapped fracture lengths vs well depth for over 2,000 fracked wells in the Barnett Shale (Fisher, 2010).



Oil and gas formations in New Mexico are all at depths of 5,000 ft or much greater, while potable supplies in the Middle Rio Grande basin are generally at depths of 2,000 feet or less, so that there are thousands of feet of impervious rock separating the deepest ground water wells and the shallowest fracked oil or gas well. Thus, migration of contaminants through a fracture from a fracked oil or gas well to an overlying aquifer is highly improbable. This is confirmed by numerous studies.

To date, there are few, if any cases where hydraulic fracturing has resulted in damage to drinking water sources (i.e., directly from the physical underground fracturing process), with one likely exception in Pavillion, Wyoming.

As discussed in *The Shale Revolution and Water Quality* (Raimi, 2018, Brief 18-06), in the eastern portion of the US (and as would generally be the case in the Rio Grande Basin) layers of shale or other low permeability formations typically separate the producing zones from the underground drinking water sources. In Pavillion, Wy., groundwater is taken from the Wind River formation which occurs at depths of a few hundred meters. Drinking water is present to that depth, although it occurs in disjointed pocket and, atypical of most locations, is intermixed with oil and gas producing zones.

In the Pavilion area, about 10% of the fracked oil and gas wells were within 750 feet (depth) of the deepest water wells, and half were within 1800 feet. State of Wyoming studies have so far found no proof of contamination. However a 2016 report (DiGuilo and Jackson, 2016) concluded that underground sources of drinking water had been impacted (but the authors don't specifically identify individual supply wells as having been impacted, only to the deeper portions of the freshwater aquifer.). This conclusion was based on concentrations of major ions in produced water, leak-off of stimulation fluids into formation media, likely loss of zonal isolation during stimulation of several production well, and detection of organic compounds in two purpose-specific monitoring wells installed during previous investigations. The two monitoring wells were drilled between 200 and 300 meters deep, roughly the depth of the deepest water well in the area and the depth of the shallowest fracking activities. They also note that detections of organic compounds were detected in wells located less than 600 meters (lateral) from unlined pits used prior to the mid-1990s.

Currently, there are no New Mexico OCD regulatory requirements addressing monitoring for fracking contaminants in nearby water wells either prior to or following oil and gas operations (i.e. no baselining requirements as would be expected under a presumptive liability regulatory schema), nor are there requirements for monitoring for stray methane gas invasion of nearby groundwater wells. As noted above, the use of pits in general, the requirements for use of liners, spill reporting requirements, and remediation and clean-up standards from oil and gas operations are currently addressed within New Mexico OCD regulations. Transportation-related incidents are addressed under differing New Mexico regulations administered through the NMED.

To put these assorted issues discussed above and in the Raimi briefing paper in perspective, along with the consensus risk pathway evaluation which considers surface spills a much higher priority than direct fracturing chemical migration, a quote from the author of the paper regarding Pavillion groundwater contamination is informative. Digulio (2016) in a subsequent interview with the Casper Star Tribune regarding the Pavilion study stated:

“Cumulatively over time, that’s a lot of fluid going into those pits. If I lived in the Pavillion oilfield, I would be much more concerned about those pits. I would view hydraulic fracturing as a long-term potential risk in need of further investigation. But if I actually lived out there, I’d be focused on those pits right now” (Johnson, 2016).

Sources/Volumes of Drilling Water

A related concern in more arid portions of the country, not specifically addressed by Raimi, is the demand for freshwater resources need for drilling and fracking operations as previously discussed under oil and gas operations. While the OSE may issue temporary permits for oil and gas operations in an amount not to exceed 3 acre-feet (roughly 100,00 gallons), a single 10,000 foot well may require on the order of 38-acre-feet of water (12.6 million gallons). Increasingly, oil and gas is turning to produced water for fracking because it is cheaper to acquire, transport, and may result in a higher quality fracking job due to similar water chemistries. Presentations at recent conferences suggest that in heavily produced areas, the use of produced water may amount to 50 to 85% percent of the water used in drilling operations. However, for wildcat wells and initial explorations, adequate produced water resources may not be readily available, and freshwater resources may be targeted as a drilling water source.

Concerns with Community Health Impacts

The proximity of oil and gas shale activities in more densely areas of Colorado, Pennsylvania, and Texas has raised concerns over the health risks of living near oil and gas production zones. Although worker exposure to fracking chemicals is of direct concern to the industry, the risk of such exposure for the general public are very small and there is little to no evidence that substantial health damages have occurred through such a pathway. (Raimi, 2018, Brief 18-04, The Health Impacts of the Shale Revolution).

However, other exposure pathways do exist such as spills and leaks of produced water, chemicals, or oil at the surface, or the rare occurrence of a well “blowout”. These pathways do have the potential to damage the environment and to expose the populace located in close proximity.

Of significant concern is the potential for air emissions that occur during well development, drilling and completions processes. These include exposure to methane releases (either by leaks, venting, or flaring), and diesel exhaust fumes from heavy-duty compressors used in drilling and development operations. During flowback operations, air emissions may include volatile organic compounds and air toxics such as benzene and hydrogen sulfide. Immediate health effects / symptoms from such exposures include eye, nose, throat, and respiratory irritations, headaches, nausea,, and exacerbation of respiratory and cardiac diseases in sensitive populations.

RFF’s Kupernick and Echarte (2017) did a literature review analyzing the effect of unconventional oil and gas development on health outcomes and focusing on epidemiological studies. The review included 32 studies covering health impacts such as birth outcomes, cancers, asthma and other health effects, including migraines and hospitalizations. Kupernick and Echarte (2017) summarized that almost all studies found a positive association between fracking and at least one health outcome (such as low birth rate) but the literature as whole produces inconsistent results for any given outcome. Due to the nature of the data available and methodologies used, the studies were unable to assess the particular mechanism of any

health impacts (i.e. by air pollution, from stressors (light, noise, traffic, community growth), water pollution, or another burden. They state that even where good evidence is offered for a link between conventional oil and gas development and health, the causal factor(s) driving the association were unclear. (Kupernick and Echarte, 2017).

The RFF website includes a listing of additional studies that have been conducted since the Kupernick and Echarte reports (the Shale Research Clearing House, <https://www.rff.org/sharc> under Environment and Health – Human Health). These include similar types of studies to those discussed above. Areas of studies have included statistical correlations between oil and gas development to various health outcomes. Such studies included:

- A Scottish government report (Health Protection Scotland, 2016) specifically dedicated to a comprehensive review of unconventional oil and gas related public health issues. The published Health Impact Assessment found evidence for some risks for air and water-borne environmental hazards primarily related to disposal, along with inconclusive evidence for other risks and many data gaps. The study concluded that there was sufficient, but limited, evidence for health risks for nearby residents related to polycyclic aromatic hydrocarbons, tropospheric ozone generation, and to waterborne total dissolved solids and metal ion. It also concluded that there was inadequate evidence to suggest that other hazards such as light, noise, or odors occurred at levels that couple poses a risk to physical health.

Similar to Kupernick and Echarte (2017), the study found that epidemiological studies were limited and of variable quality and characterized by contradictory and inconsistent findings. As a result there was inadequate epidemiological evidence upon which to draw conclusions on associations between oil and gas activities and specific health comes, vis: reproductive and developmental health; childhood cancer, or neurological, cardiovascular, or dermatological health outcomes.

(<https://www.hps.scot.nhs.uk/enviro/unconventionalgas.aspx>)

- Evidence of elevated benzene metabolites in gestating females in the Peace River Valley of Northeastern British Columbia, based on monitoring of a small sample set (Careon-Beaudoin et al, 2018).
- Increased risks from non-methane hydrocarbons (benzene and alkanes) based on acute hazard indices for neurological, hematological and developmental health effects for populations living within 152 meters (500 feet) of an oil and gas facility based on ambient air sampling. (McKenzie et al, 2018).

Acute and chronic non-hazard risks for residents living beyond 500 feet are generally less than a Hazard Index of 1 for all individual VOCs emitted from oil and gas operations in Colorado, while hazard indices for combining exposures for all 56 VOCs considered is slightly greater than 1 (McMullin et al, 2018).

- Potential statistical correlations with depression symptoms in oil and gas development areas (Casey et al, 2018) , cardiovascular indicators (McKenzie, Crooks et al, 2018), hospitalizations related to genitourinary and skin related issues (Denham

et al, 2018), and a 20% increase in certain sexually transmitted diseases presumably due to a mobile workforce (Deziel et al. 2018) associated with oil and gas employment. However, causal relationships are not established in those various studies.

- A limited, 18-person solicitation panel regarding the appropriateness of recommended setback distances from oil and gas activities. The panel consisted health care providers, public health practitioners, environmental advocates, and researchers/scientists, with “agreement” based on a 70% consensus standard. The panel evaluated consensus derived setback options including $< \frac{1}{4}$ mile (1,320 feet) as a minimum setback.

The panel agreed that setbacks of less than $\frac{1}{4}$ mile should not be recommended, but did not reach consensus on greater set-back categories due to limited exposure studies. The panel was in agreement that setbacks greater than $\frac{1}{4}$ miles should be applied for vulnerable groups including schools, daycare centers, and hospitals.

Concerns with Increased Seismicity and Earthquakes

The primary concern with induced seismicity results from disposal of oil and gas wastewater and/or produced water (i.e. disposal operations rather than physical fracturing operations). Under certain geologic conditions, the disposal of large volume of fluids may alter subterranean pressures enough to allow an existing fault to slip. This has been the primary cause of reported earthquakes in Oklahoma, Arkansas, Kansas, Ohio, and Texas. Most injection operations, however, do not appear to induce “felt” earthquakes (Rubinstein and Mahani, 2015).

The relevant Raimi Brief (Raimi, 2018, Brief 18-01, The Shale Revolution and Earthquakes) provides an overview of the key cases of oil and gas activities that have led to a sharp rise in human-caused earthquakes, or “induced seismicity. There are relatively small number of cases where hydraulic fracturing (i.e. the physical process of fracturing) have induced surface measured seismic events, but a small number of minor quakes in Ohio, Oklahoma, Texas and United Kingdom are noted, as well as a magnitude 4.6 quakes occurring in Canada (Bao and Eaton, 2016). Increased occurrence of earthquakes has been noted in regions of the country with extensive development of oil and gas resources, especially in central Oklahoma, and southern Kansas. This phenomenon is referred to as induced seismicity. Figure 4 (Scanlon et al., 2019) plots the seismic events with magnitude (M) ≥ 2.5 in Kansas, Oklahoma, New Mexico, and Texas. There has been little or no increase in earthquake activity in shale gas states such as Colorado, North Dakota, and in Pennsylvania (where little wastewater injection occurs).

In general, these type of fracturing induced events are related to fracture that activates previously unknown faults, are short-lived, of low magnitude, and do not result in surficial property or building damage. Induced seismicity can also be caused by oil and gas extraction activities, as well as fracturing and fluid injection, or both in combination as has been suggested for seismicity near Azle, Texas (Hornback et al., 2015).

The reactivated faults could be intersected by the well bore, or it could be 100s of meters distant. (Davies et al.,) 2013. The mechanisms for induced seismicity from fracturing may occur by three or more mechanisms:

- fracturing fluid/displaced pore fluids entering a fault,
- direct connection of the fault with the induced hydraulic fractures and transmission of a pressure pulse to the fault, and/or
- deformation or expansion of rock could increase fluid pressure in the fault or the fractures connected to the fault.

The transfer of fluids or a pressure pulse could be:

- directly from the wellbore penetrating a fault zone,
- through new induced fractures,
- through preexisting fractures or faults intercepted by the wellbore or connecting induced fractures, and
- through the pore network of permeable beds or along bedding planes.

The recorded seismic instance in the United Kingdom yielded a recommendation that fracturing operations be accompanied by seismic monitoring and that locations of faults be assessed prior to drilling to avoid hydraulic fracturing near faults. The resulting study further recommended that operations be stopped if a tremor magnitude of 0.5 or greater is detected, as that level is well below what could be felt at the surface and is within the range of normal background noise caused by vehicles, trains, and other activities. The 0.5 magnitude level is, however, above the level expected from normal fracking operations (Department of Energy and Climate Change, 2014).

The National Research Council convened a panel of scientists and engineers to study induced seismicity which concluded that hydraulic fracturing for unconventional oil and gas production “does not pose a high risk for inducing felt seismic events” (NRC, 2013). Instead it is the deep well injection of the very large volume wastewaters from oil and gas production, usually referred to as produced water that increases the risk of seismicity. Interestingly, the NRC panel noted that injection of fluids containing captured CO₂ as a result of carbon capture and sequestration may have potential for inducing large seismic events.

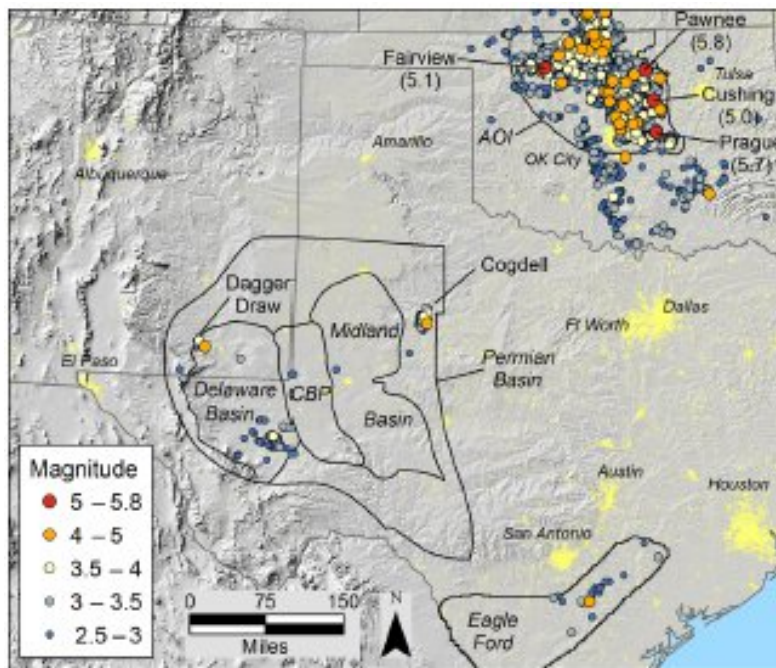


Figure 7. Seismic events with magnitude (M) ≥ 2.5 between January 2009 and December 2017 (Scanlon et al., 2019).

Scanlon et al. (2019) discussed the relationship between deep well injection of produced waters and enhanced seismicity and found that, in addition to the volume and injection pressures, the proximity of the injection zone to the underlying crystalline basement rocks increased the earthquake risk. They noted that two reasons increased seismicity hasn't been detected in the New Mexico and west Texas in comparison to Oklahoma and Kansas is that; 1) the depth to basement rock in the Permian Basin is much greater and 2) because of the remote location, there are few seismic monitoring stations. Nevertheless, Snee and Zoback (2018) note the potential for significant earthquake development in this basin.

The depth to basement rock in the middle Rio Grande counties varies from greater than 10,000 feet along the river to less than 3,000 feet near the edge of the basin. It is clear that depending on location, deep well injection of large volumes of produced water may increase the risk of induced seismicity if it were to occur.

Concerns with Effects on Local Governments

The Effects of the Shale Revolution on Local Government (Raimi 2018, Brief 18-05) – Increased natural gas and oil production has affected local government revenues and services in over a dozen US states, leading to higher revenues for most local governments, even after the downturn in oil prices in late 2014. However, the growth increase demands for a variety of local government services. Raimi (2018, Brief 18-05) reports that revenues have outweighed increased demand for services for 74% of local governments nationwide, 14% report roughly neutral impacts, and 12 % reporting negative fiscal impacts. Rural areas where oil and gas development expanded rapidly such as the Bakken in North Dakota faced net

negative fiscal effects, as have other highly rural areas in Kansas, New Mexico, Oklahoma, and Utah.

Krupnick et al (2017) reviewed the academic literature on the effects to local government. Based on the 19 studies reviewed, most deemed to be of high quality, the correlated impacts to local governments from oil and gas development includes:

- an increase in state revenue sharing (depending on state financing structure),
- increases in local tax receipts,
- increase in water and sewage infrastructure demands,
- increase in general local governmental expenditures,
- a mixed correlation to increased local governmental debt, and
- increased governmental staffing for law enforcement, fire and emergency services, social services, and governmental administration.

Citing to Bartik et al. 2017, Krupnick et al (2018, p.10) indicate across counties, unconventional oil and gas development was “largely budget neutral” – expenditures increased by 12.0 percent while revenues increased 15.5 percent. That public safety expenditures increased about 20 percent, infrastructure and utility expenditure increased 24 percent, and welfare and hospital expenditures increased about 24 percent, and with little increase found in educational expense. Increases in revenue resulted from increases in property tax revenues and other general revenue streams. An annual “willingness to pay” for fracking-induced changes in local amenities are roughly equate to \$1000-\$1,900 per household annually. Bartick et al (2017) also comment that there is deterioration in the quality of life or total amenities, including marginally significant estimates of higher violent crime rates despite increased law enforcement spending.

In terms of costs, road maintenance (related to oil and gas traffic) was the greatest cited cost to local government. Counties in North Dakota have not been able to keep pace with the rapid demand for road repair, while many Pennsylvania counties have experienced limited costs because they have agreements with natural gas companies to repair roads (Krupnick et al, 2018).

One gas well is estimated to need 400 to 1,200 one-way heavy truck trips, and multiple wells may be drilled on a single well pad. These trips add up over time, causing damage to roadways and burdening local communities with increases risk of traffic accidents and contribution to local air pollution. (Krupnick et al. , 2018).

Based on studies from Pennsylvania, one well can cause up to \$23,000 in road damage, assuming 1,148 truck trips, travelling 20 miles each direction on local roads. Greenhouse gas emissions from truck transport of water are estimated to 70-157 tons of carbon dioxide per gas well, with a social cost of \$782-\$1,755 in damages per gas well. Truck accident rate increases are calculated to be on the order of 0.3 % in the first three months after a well is drilled, and on highways without ramps or interchanges, the increase in truck accidents is about 0.9 % per well. (Krupnick et al., 2018 p.14).

However, a study from rural South Texas suggests that crash trends in that area increased by 26 % and fatalities and sever injuries increased by 49 %, and reports road damages being as great at \$133,000 per well in areas where roads were initially constructed for only light duty

use and drilling activity was its most intense (Rahm et al., 2017). A Boulder County, Colorado Impact fee assessment study sets the impact fee for oil and gas activities at \$1,200 per well pad, \$30,600 per well for road deterioration, and assess an additional \$6,200 per well as a safety fee (Felsburg, Holt, and Ullevig, 2013).

A secondary impact is that net increases in local governments revenues are offset by the factors listed above as well, as well as reduction in property values when near vicinity (1/2 mile) of oil and gas operations. Again, Krupnik and Echarte (2017) have performed a literature review of available studies. In a review of 16 studies, they find that the results are relatively conclusive, indicating strong evidence for decreases in values of up to 26.6 %, for *ground-water dependent* homes within 6,562 feet or 1.2 miles, and a decrease of over 35 percent for homes not associated with a mineral right. There is also strong evidence for smaller increases in value (3.4 %) depending on the distance to a well or well pad for homes *on municipal-type systems*.

In the Tarrant County, Texas region, existence of oil and gas wells within 3500 feet of a property reduces property values by approximately 1.5-3 %, but the reduction seems to be driven by unconventional wells rather than conventional vertical wells. Active well construction causes an added 1-2% reduction in home value (Balthrop and Hawley, 2017).

Bennet and Loomis (2015) suggest that in Weld County, Co., the impacts differ for rural and urban housing values. The number of drill sites within a half mile radius of the house did not have a statistically significant effect on housing values, but values decreased by \$12/meter of decreased distance (or about distance from the nearest well increased housing prices by \$12/meter of offset (\$19,308/mile, or based on median home values about 7.4 %). In more urban setting, the number of wells drilling at the time of sale had a statistically significant decrease on how prices, but the effect was less than 1% for each well being drilled within a half mile of a house (similar to the value cited for Tarrant County), and slightly less than the decline in values associated with proximity to Confined Animal Feeding Operations and their associated odor. The authors suggest that in urbanized areas, the use of more horizontal drilling from a single well pad may help minimize the effects of the having a larger number of wells located with a more densely urbanized area. They also indicate that oil and gas employment has a small positive effect on house prices of less than 1% of purchase price.

James and Smith (2017) examine how energy booms have affected crime rates through the country. They provide a brief literature overview and acknowledge that among policy makers there is a lack of consensus that energy booms attract or produce criminal activity. The scant literature summarized includes a 2011 study that failed to find unconditional evidence for higher crime rates in North Dakota and Louisiana; a 2009 study providing some limited evidence of increased crime in Sublette, Wyoming; a 2012 study that finds no evidence in crime rates associated with shale gas extraction in Pennsylvania, and a 2015 study that finds some evidence, though not differentiated by type, associated with energy booms, in general.

Gourley and Madonia (2018), however, find a positive correlation between the well density of a county and both violent and property crimes. James and Smith (2017) also report a positive-correlation with rates of various property and violent crimes in shale rich counties. In particular, James and Smith (2017) report significant positive effects on rates of aggravated and simple assault, larceny, and grand theft auto, and more moderate effects for

burglary and forcible rape. They note that these rates are substantially larger in less-densely-populated areas and in the mountain west region. They also report evidence that persons with criminal records (registered sex offenders) moved disproportionately to shale-boom towns in North Dakota, and they also document a rise in income inequality (a potential determinant of criminal activity) that coincides with the time of the energy boom.

Despite these findings, James and Smith (2017) also indicate that at the end of their statistical sampling period, the cost of the induced criminal activity in a typical treatment county was just 2.5% of the income gains.

Synopsis of Other Ordinances (Steve)

The Intermountain Oil & Gas BMP Project at University of Colorado Boulder maintains a non-exhaustive database of existing state and local oil and gas ordinances and regulations (<http://www.oilandgasbmps.org/laws/>). Within the database, there is a summary of numerous oil and gas development ordinances and regulations adopted (or proposed) by New Mexico local governments (http://www.oilandgasbmps.org/laws/new_mexico_localgovt_law.php). A brief review of New Mexico oil and gas ordinances and regulations was conducted using this resource.

According to the Intermountain Oil & Gas BMP Project website:

“A number of New Mexico counties and municipalities have enacted laws covering oil and natural gas development. These local provisions supplement state and federal law and include permitting programs and best management practices, and vary in both the stringency of their requirements and in what they actually require. Many New Mexico counties and municipalities have not enacted any additional laws and rely on the state and federal framework to regulate development.

Under N.M. STAT. § 3-17-1, municipalities can pass ordinances "not inconsistent with the laws of New Mexico" to discharge powers and duties and to provide for safety, health, and prosperity of residents or order of the municipality. N.M. STAT. § 4-37-1 grants similar powers to counties. In addition, under N.M. STAT. § 3-18-17, any municipality or county with a floodplain or plains must have an ordinance that establishes building and permit requirements for construction – including that of oil and gas facilities – in floodplains.”

County Ordinances

Several New Mexico counties regulate oil and gas development through ordinances that prohibit flood damage, require solid waste management plans, stipulate set-backs from certain properties and/or require special use permits for oil and gas development operations. Examples include Bernalillo County, Eddy County Grant County, Lincoln County, Luna County, Quay County and San Juan County.

A specific example of this generalized approach to regulating oil and gas development is **Bernalillo County**. Flood damage prevention is regulated by defining "drilling operations" as regulated development and requiring that development in flood hazard areas be done only after obtaining a development permit. Solid waste management provisions define "petroleum contaminated soils" as a form of special waste subject to additional "handling, transportation, or

disposal requirements" as determined by county officials. Special Use Permit regulations classify oil and gas "drilling, production, and refining" as a special use. Such uses can be granted or denied based on general safety, health, and welfare concerns. Applications for such uses must include planned grading and drainage at the site, information on landscaping and buffering, and are subject to a public hearing requirement.

Other New Mexico counties have adopted ordinances that more specifically address aspects of the oil and gas development process. Examples include Rio Arriba County, San Miguel County, Santa Fe County and Valencia County.

Rio Arriba County enacted in 2009 a zoning and public nuisance ordinance to protect and promote the health, safety and general welfare of present and future residents of the County while at the same time providing for the responsible and economically viable extraction of oil and gas minerals. The ordinance splits the county into two districts, each with specific rules regarding oils and gas development. Oil and gas development in the Energy Resources Development District requires a development permit for oil and gas facilities; the Frontier District requires approval of a special use permit.

Specific provisions of note in the ordinance include:

All exploratory permit applications must contain a copy of the applicant's county business license; a discussion of possible surface disturbances, affected acreage, and mitigation measures; and a map showing geographic and topographic features and human development, including emergency facilities.

San Miguel County enacted an ordinance in 2014 to regulate oil and gas exploration and drilling in the county. Drilling is restricted to a sparsely populated stretch on the eastern side of San Miguel County. The ordinance is intended to regulate all aspects of oil and gas projects from exploration, drilling, fracking, production, transportation, abandonment, to remediation through the issuance of Conditional Use Permits (CUP), via two distinct application processes. The ordinance includes provisions requiring minimum set-back distances from structures and water resources; land and environmental suitability determination; an environmental impact report; assessment of the adequacy of public facilities and services; a water availability assessment; a traffic impact assessment; a geohydrologic report; an emergency response plan; and a fiscal impact assessment. The ordinance further establishes performance standards including in part firefighting, appearance of drill sites and visual impacts, water quality protection, fracking and acidizing, noise and light pollution, setbacks, financial assurance, flares, security and brine disposal, and ongoing monitoring for radioactivity at every well or pad.

Oil and gas projects must furnish a deposit to cover the County's expenses in reviewing the application. Last, the ordinance requires that administrative remedies be exhausted before an applicant institutes litigation as to a regulatory taking without just compensation, and sets forth the matters which shall be submitted and considered.

Santa Fe County

Santa Fe County is the location of the Galisteo Basin in the northcentral part of the state. Visit the website of the [Santa Fe County Board of Commissioners](#). Santa Fe County's oil and natural gas ordinance, adopted in December 2008, is intended to govern "exploration, drilling, production, transportation, abandonment and remediation," and provides for a three step permitting process for oil and gas development.

The permitting process itself provides for discretionary approval of the required zoning classifications and special use and development permits, and also an approval requirement for grading and building permits.

Valencia County

Valencia County is located in the central part of New Mexico, near Albuquerque. To visit the website of the [Valencia County Board of Commissioners](#). There is no major oil and gas basin in the county. The county has a number of zoning provisions that are relevant to oil and gas development.

Municipal Ordinances

Approximately a dozen New Mexico municipalities have adopted ordinances addressing oil and gas development, according to the Intermountain Oil and Gas BMP Project. These include Aztec, Bloomfield, Carlsbad, Deming, Edgewood, Farmington, Gallup, Hobbs, Lovington, Moriarty, Raton and Roswell.

Water Resources Protection in NM County Ordinances					
Topic	Rio Arriba	Santa Fe	San Miguel	Valencia	
Use of freshwater resources for oil and gas activity	6.17 Water Quantity				
Potential for contamination of ground water supplies from subsurface drilling activities	6.17 Water Quality 6.18 Grndwtr Mntrng 6.19 Grndwtr Smplng				
Potential for contamination of surface water supplies from subsurface drilling activities	6.2 Setbacks 6.11 Waste 6.17 Water Quality				
Disposal and reuse of flow-back and fracking fluid and produced water	6.11 Waste				

Emergency Response Planning in NM County Ordinance					
Topic	Rio Arriba	Santa Fe	San Miguel	Valencia	
Emergency Services Limitations (County/municipal)	6.7 Fire Prevention and Emergency Response				
On-call response guarantees / protocols					
Emergency and Contact information currency					
Community Notification Plans					

II. Legal Basis and Limitations of Local Ordinance and Regulation.

There are three fundamental legal concepts particularly germane to the development of local oil and gas ordinances:

- Preemption (which defines the relationship/interaction between federal, state, and local legislative and enforcement powers);
- Regulatory Takings (which limits the governmental regulatory powers when such activity occurs without providing fair compensation); and
- Regulatory Approaches to Liabilities (which serves to assign the risks, responsibilities, and consequences for a particular action and includes general negligence, presumptive liability, and strict liability approaches).

The issue of preemption presents a dichotomy as expressed by Dana and Wiseman (2015): regulatory enforcement via an exclusive regulator (typically the state) versus overlapping and redundant enforcement by multiple sets of regulators operating in different political environments. Regulatory approaches to liability considerations also present a dichotomy: direct regulation via legislative or governmental agency action contrasted to indirect regulation via court implemented tort liability for environmental harms.

Preemption

Local governmental authority for regulation of oil and gas activities is constrained by the principle of “preemption”. Preemption is defined as “a doctrine of American constitutional law under which states and local governments are deprived of their power to act in a given area, whether or not the state or local law, rule or action is in direct conflict with federal law” (ABA). If the federal (or state) governmental bodies or agencies have enacted legislation on a subject matter it is generally controlling over state (or local) laws and or preclude the state (or local governments) from enacting laws on the same subject if Congress (or state legislatures) have specifically declared it has “occupied the field.” The State of New Mexico does not make any such explicit presumption statement in its current oil and gas regulations.

Preemption falls into one of three categories (Lam, 2016):

- Express Preemption requires explicit statutory language expressing a clear intent of the state to prohibit local regulation;
- Field / Implied Preemption may apply if a state regulation in a specific subject is so comprehensive that it is clear the state government intended to fully occupy the field; and
- Conflict preemption applies when, absent express preemption, a local law conflicts with a federal or state law making it impossible for a party to comply with both laws.

A presumption against exercise of preemption is stronger in some categories and weaker in others. If the subject matter was “traditionally regarded as properly within the scope of state superintendence” [or local government in this instance] or a matter of public health or safety, then the courts rely more heavily on the presumption that states [local] will continue to have an important role. Advocates for preemption must show more than an “obscure grant of authority to regulate areas traditionally supervised by the states’ police power” (ABA).

Local leaders in more than 530 localities across twenty-six states have acted to prohibit fracking within their jurisdictions. As stated by Riverstone-Newell (2017),

“In addition to water quality concerns, local leaders point to possible harms to property values, increased seismic activity, and the disruptive effects of the rapid population growth that accompanies fracking operations, including disruption to education systems, insufficient emergency services, housing shortages, rapid commercial and residential development, increased traffic, and other inevitable lifestyle and quality of life changes (Bartick et al. 2016). Given these stakes, may local officials believe that they are best positioned to determine local needs and preferences, and that it is their responsibility and duty to protect the health and safety of their communities. The means by which localities attempt to control fracking include land-use plans and zoning ordinance, ballot measures that regulate or ban fracking outright, resolutions calling for statewide bans, and temporary or long-term moratoria. Of the twenty-six states involved in these local efforts, four have their own statewide fracking bans, but two have no shale plays, so their bans are clearly symbolic. Localities in six states have also symbolically based bans – symbolic because there are no viable shale plays in their states (Connecticut, Hawaii, Maine, Minnesota, New Jersey, and Wisconsin).”

Over the past several years, a growing number of states have considered and enacted laws overturning and preempting local regulations related to oil and gas development, particularly bans on hydraulic fracturing (fracking). State courts have generally overturned local bans in favor of state preemption, and state leaders have introduced preemption legislation in nearly every state where local bans have been enacted (Riverstone-Newell, 2017).

Ritchie (2014, p.284-285) notes that with a view of New Mexico under-regulating fracking, that New Mexico counties most directly affected by a disproportionate share of externalities would presumably invite additional local regulation, but that has not proven to be the case. Rather, cities and counties with no drilling activity to speak of seem to be leading the charge to ban oil and gas production. Ritchie (2014) points to this as an example of the economic “free-rider problem” where oil and gas revenues are distributed statewide and not proportionally to the counties dealing with the related externality issues. Ritchie (2014) also points to possible “public choice theory” motivations, and the potential for “small group-pressure liberalism driving policy decisions” (Ritchie 2014, p. 289), particularly when such groups are operating from a “successful failure as motivation” to challenge established federal and state authorities, as was the case in Mora County, New Mexico.

Riverstone-Newell (2017) points out that in Pennsylvania, localities were granted some room to regulate fracking after the state supreme court held that the state’s preemption law was unconstitutional (*Robinson Township v. Commonwealth of Pennsylvania*, Ps. 2013). However, rather than asserting local land use or police powers, which were the grounds used for protesting state preemption, the court chose to cite the state constitutions’ Environmental Right Amendment, which holds the state and localities as trustees for “clean air and pure water”, a function that necessitates local control over zoning and land use planning. The original Mora County, NM oil and gas ordinance claimed such a duty for the local government. The presiding District Court declared the entirety of that Ordinance invalid. It is noted that New Mexico has no such environmental right provisions in its state constitution.

By way of detailed example, Riverstone-Newell (2017) discusses that Texas, an “oil friendly” state, has historically allowed localities to regulate the oil and gas industry in keeping with state regulations. This has been the norm since the 1980s, when the Texas Court of Appeals found that

municipalities have the power to regulate drilling and to prohibit drilling without a permit. (*Unger vs State of Texas, Tx. Ct. App 1982*). That case was argued based on local zoning authority, but the court chose to base its decision on municipal police power, whereby cities can act “for the protection of their citizens and the property within their limits, looking to the preservation of good government, peace, and order therein”. Following the 1982 Texas court case, Texas municipalities subsequently passed a number of ordinances regulating among other matters, “noise levels, drilling of fresh water wells, compressor stations, landscaping and screening, drilling within a floodplain, saltwater disposal, measures for controlling water quality, road repairs, and...allowable distance(s) from existing structures that wells may be drilled” (Smith 2011, 142). Items such as those are reflected in the existing City of Fort Worth oil and gas ordinance.

In contrast, the City of Denton, Texas in 2013 attempted to enforce local increased oil and gas set back distances of 1,200 feet from the state specified 600-feet. Objections were raised due to a conflict with state permit conditions and subsequently led to the City of Denton dropping a request for a constraining order because “the well permits from the Railroad Commission preceded the setback ordinance” (i.e. they were deemed to have been ‘grandfathered’ based on state requirements.)

In 2014, the populace of Denton determined by ballot initiative to ban fracking outright, but before enactment as ordinance, legal challenges were filed. The General Land Office (equivalent to New Mexico State Land Office) sued the City asserting that state law preempted such actions, as a ban was inconsistent with the general laws of the State. More specifically, the preemption was based on the Railroad Commission of Texas having been granted jurisdiction over oil and gas wells, and furthermore, it impaired the General Land Office Commissioner’s ability to manage and operate the State’s mineral interest. The Texas Oil and Gas Association also immediately filed an injunction claiming 1) preemption by implication, 2) conflict with the existing Railroad Commission Regulations, and 3) field preemption by delegation of authority to the Railroad Commission and the Texas Commission on Environmental Quality (Lam, 2016).

The Texas Legislature, in response to the matter, then passed House Bill 40 (2015). To avoid lengthy legal battles, the City of Denton subsequently repealed its ban. Following Texas’ lead, Oklahoma and North Carolina passed fracking preemption laws in 2015. (Riverstone-Newell, 2017, p. 410). In Colorado and Louisiana, the states fought local actions by asserting that existing law granted them preemption authority, and their courts affirmed this position. In May 2016, the Colorado Supreme Court determined that regulation of the natural gas industry is not purely local, as it has an economic impact on the state.

Texas’ HB 40 cited authority previously delegated to the Railroad Commission of Texas as the basis for explicitly preempting regulation of oil and gas and asserted that the state has exclusive jurisdiction over sub-surface activities because previous state regulations in the oil and gas sector were “so comprehensive and pervasive that it occupies the field...”. The bill went on to state that preemption was done while “facilitating the overriding policy objective to fully and effectively exploit oil and gas resources and protecting the environment and public’s health and safety.” HB 40 also asserted that the intent of the legislature was to preempt expressly “regulation of oil and gas operations by municipalities and other political subdivisions that is already impliedly preempted by state law.”

Lam (2016) indicates that neutral legal observers generally agree that HB 40 limited the ability for cities to protect the health, public safety and property of Texans who live in areas with heavy drilling activity. In particular, under HB 40 a municipality is authorized to enact, amend, or enforce any ordinance or other measure (Lam 2016) that:

- regulates only above ground activity that is incident to an oil and gas operation,
- is commercially reasonable,
- does not effectively prohibit an oil and gas operation conducted by a reasonably prudent operator, and
- is not otherwise preempted by state or federal law

It also provided for limited local control of “above ground activities” including regulating traffic noise, and the minimum distance new wells could be placed from residential or public buildings. (Lam, 2016).

Of particular interest for local New Mexico ordinances, the State of New Mexico delegates oil and gas authority to the Oil and Gas Conservation Commission and the Oil Conservation Division in a manner very similar to the Texas delegation statutes. Although the State of New Mexico has not passed an explicit preemption provision, the argument in Texas for doing so was a long-standing implicit preemption intended by the state provisions. A similar argument could be made by the State of New Mexico. Fortunately, some of the state explicit and implicit preemption issues raised in HB 40 were addressed directly by the US District Court in the challenge to the original Mora County, NM oil and gas ordinance case. (*SWEPI vs Mora County, New Mexico* CIV 14-0035 JB/SCY).

The original Mora County oil and gas ordinance had a specific provision (Section 5.9) that stated that federal and state law were only preemptive when stated as being expressly preemptive and when such laws and regulations provided greater protection. The provision was found to violate the Supremacy Clause and the Court specifically struck down this provision. The Court expressly ruled that the Supremacy Clause provides that federal law preempts contrary state and local law and specifically decied a reference to the Mora County ordinance where it was in conflict with state law by prohibiting activities that state law permits: specifically, the production and extraction of oil and gas. The Court also specifically ruled against Mora County’s assertion that a local zoning ordinance could be made to apply to New Mexico state lands.

However, the Court also clearly stated that existing New Mexico oil and gas statutes and regulations do not impliedly preempt the entire oil and gas field despite a prior New Mexico Attorney General’s letter advising such a position. In particular, the ruling cites to intervening New Mexico case law and allows that the Oil and Gas Act does not address “the kinds of ... issues “with which local governments are traditionally concerned”. The court specifically lists issues such as traffic, noise limitations, potential nuisance from sound, dust, or chemical run-off, or the impact on neighboring properties. In the Mora County ordinance case, the Court specifically states that there is room for concurrent jurisdiction between state and local law and that local ordinance is not preempted under the field preemption doctrine.

Ritchie (2014) addresses the role of local entities within the context of the Cooley doctrine and Dillon Doctrine. Cooley, a former chair of the Interstate Commerce Commission, held that the “state may mold local institutions according to its views of policy or expediency; but local government is a matter of absolute right; and the state cannot take it away”. Cooley is premised on the notion that “framers of constitutions assume principles of local self-governance, whether or not expressly stated, and as implied restriction on legislative power.” However, Dillon, a state and federal judge and former president of the American Bar Association in 1872, has held sway through the years. The Dillon Rule stems from a treatise where in Dillon propositioned that:

It is a general and undisputed proposition of law that a *municipal corporation possesses and can exercise the following powers, and no other*:First, those granted in

express words: second, those *necessarily or fairly implied* in or *incident* to the powers expressly granted; third, those essential to the accomplishment of the declared objects and purposes of the corporation – not simply convenient, but indispensable.

Ritchie (2014) further explains that preemption in New Mexico is premised from the test developed in *Board of Commissioners of Rio Arriba County v. Greacen*. In that case, the county had enacted a traffic ordinance that duplicated state traffic laws, except that it directed payment of penalties back to the county. The test asks whether:

- “the ordinance permits an act the general law prohibits, or vice versa”.

That ruling also indicates that:

- “where the local ordinance merely complements and is not antagonistic with statute, the ordinance will stand”

and further explains that ordinance is in conflict with state law “when state law specifically allows certain activities or is of such a character that local prohibitions on those activities would be inconsistent with or antagonistic to that state law or policy”.

However, in *San Pedro Mining Corp v. Board of County Commissioners of Santa Fe County*, the New Mexico Court of appeals extends the test to include additional elements by holding that:

- a state statute may preempt a local ordinance either expressly,
- impliedly because there is a conflict between the state statute and the ordinance, or
- impliedly because the state statute demonstrates an intent to occupy the entire field.

More specifically in *San Pedro* the state ruled with respect to the New Mexico Mining Act that:

“neither the act nor the regulations contain any mention of development issues with which local governments are traditionally concerned, such as traffic congestions, increased noise, possible nuisances created by blasting or fugitive dust, compatibility of the mining use with the use made of surrounding lands, appropriate distribution of land use and development, and the effect of the mining activity on surrounding property values.”

However, the effect of home-rule provisions on preemption must also be considered. New Mexico counties are granted the same powers that are granted to non-home rule municipalities, except where that are inconsistent with limitations placed on counties. (NMSA 4-37-1). Accordingly, Ritchie (2014) states that municipalities (or counties) that are not home-rule have no inherent right to exercise the police powers; as that right derives from authority granted by the state.

However, legislative home-rule power is based on the premise that municipalities and counties granted such status have full legislative power, “subject only to the power of the legislature to deny local authority by state statute” (Ritchie, 2014, p. 303). However, a home-rule entity “may not exercise legislative powers or perform functions, “expressly denied by general law or charter”. A “general law” applies generally through the state, as opposed to a local law that effects the inhabitants of the locality.

Ritchie (2014) suggests, however, that it is not clear that home-rule status in New Mexico materially changes the relevant preemption tests. Ritchie cites to *Smith v. City of Santa Fe*. This case involved a

city ordinance prohibiting the drilling of water wells within the city limits in contrast to the state's automatic and unrestricted permit schema for addressing domestic wells. Ritchie (2014) points out that the New Mexico Court of Appeals addressed an implied preemption and held that there was "no evidence of any intent to regulate the use of domestic wells in areas of concern to a municipality, including the depletion of local aquifers, impact on the quality of the local water, and reliability of the water system." The state Supreme Court upheld that ruling. Similarly Ritchie (2014) points out in *Titus v. City of Albuquerque*, dealing with red-light cameras, the New Mexico Court of Appeals held that the camera program was not preempted by the state motor vehicle code and cited both to *Greacen* and to the three part preemption test discussed above from *San Pedro*.

The implications of the above case law and examples are several:

- Proposed local oil and gas regulations should consider the ramifications of implicit preemption and the possibility of legal ramifications of "field preemption" when determining the scope of a proposed ordinance. Based on the Mora County ordinance history, it is probable that an ordinance that expressly prohibits or bans (as contrasted to constraining or providing increased protection from) a particular oil and gas activity allowed by state law are likely subject to legal challenge, particular if the ordinance is addressing a subsurface activity specifically allowed by state law (i.e. implicitly preempted).
- Ordinances should be formulated in such a manner that the local ordinance does not in any way materially interfere with the ability of an oil and gas owner or operator to conduct an operation specifically required or allowed under state regulation.
- Ordinances should be promulgated with the understanding that it will likely not be able to be applied to lands under tribal, federal, or state control, or possibly even to land grant properties still under zoning control of the owning land grants (i.e. lands not under local entity jurisdiction).
- Local entities should consider that local ordinances have some considerable latitude in dealing with surface activities, but are likely severely constrained on addressing subsurface activities, as indicated by rulings on previous challenges to the City of Fort Worth oil and gas ordinance surface provisions but with the subsequent passage of HB 40 preempting involvement in subsurface activities.
- There may be some limited latitude to deal with subsurface issues if those issues are not within the intent of general law to regulate such concerns and/or can be shown to be of particular local interest (such as depletion of local aquifers, impact on the quality of local water, or reliability of the water system per *Smith v. City of Santa Fe*).

Regulatory Takings

Local ordinance that regulates the use or exercise of a property right are subject to examination for potential governmental taking claims. In New Mexico and many other western states, the state recognizes a mineral right as real and private property, and use of lands for exploration and production of oil and gas involves the exercise of property ownership and use of such rights. The Fifth Amendment of the United States Constitution provides, in part: "Nor shall private property be taken for public use without just compensation." Alternatively, more directly, the New Mexico

Constitution Article II, Section 20 states, "Private property shall not be taken or damaged for public use without just compensation".

Local oil and gas ordinances will generally not involve the exercise of eminent domain prerogatives of the local government. Government takings are typically recognized when they occur as direct condemnation, such as when a government overtly exercises its constitutional power of eminent domain and initiates a direct condemnation process to acquire private property for some public use. In such cases, generally the only issue to be resolved is the amount of fair compensation for the owner. (Barron, 2015, p.13-4) [See the later section Compensation for Taking Actions for a discussion regarding problems in determining a just and fair compensatory value in the oil and gas context].

In the creation and enforcement of oil and gas ordinances, local entities are more likely to exercise a taking within the realm of "inverse condemnation" rather than through its use of eminent domain. Indirect or "inverse condemnation" may occur when the government physically occupies property, denies access to property, or precludes a property owner from realizing any economic or other benefits from the property (Barron, 2015, p.13-4). There are two primary types of inverse condemnation takings: possessory and regulatory.

Possessory takings are not typically the result of oil and gas ordinances promulgated to date, as the ordinances tend to preclude an activity rather than promote the use of lands against the property owners uses. Examples of possessory takings may include such things as inundation of land or erosion of waterfront property resulting from a public works project, or the forced placement of groundwater monitoring wells to assess the extent of a groundwater plume.

However, governments may also exercise their regulatory and policing powers to such an extent that a "regulatory taking" may have occurred. Local regulations have the potential to be considered a "taking" pursuant to the Fifth Amendment of the United States Constitution, particularly when a regulation bans an activity or otherwise significantly devalues an owner's property or related rights. In such cases, the owner may be entitled to compensation. Compensation may be given for both temporary and permanent takings (Jourdan and Strauss, 2016, p.109)

The concept of regulatory takings originated in a mineral rights case titled *Pennsylvania Coal Co. v. Mahon*. In *Mahon*, the issue was whether a state statute that forbade coal mining that would cause subsidence to any inhabited residence went so far as to effect the taking of a coal company's property interest in the coal located under a private homeowner's house. In the *Mahon* opinion, Justice Holmes held that "to make it commercially impracticable to mine certain coal has very nearly the same effect for constitutional purposes as appropriating or destroying it." (Barron, 2015, p. 13-7). The parallel with outright banning of oil and gas operations, or banning them if there were certain resulting impacts to other affected parties appears intuitive.

The Court considered only "whether the police power, can be stretched so far", and held that the police power, though valid, was not so broad, and that "... while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking". The courts have endeavored to differentiate the fine distinction between measured regulatory activity consistent with the police power, and regulatory action that, upon reaching "a certain magnitude... requires an exercise of eminent domain and compensation".

An amplifying case is provided in *Keystone Bituminous Coal Association v. Debenedictis* (Viviano, 2013) and help constrain the decision reached in *Mahon*. In that case, although half of the coal deposits were required to be left unmined so as to provide structural support to prevent subsidence, the Court found that the purpose of the Pennsylvania law was to arrest a significant threat to the public welfare. Therefore, the character of the action leaned heavily against finding a taking, and

particularly so as an economic benefit remained even with requiring significant coal deposits to remain.

As outlined by Barron (2015, p.13-8), this distinction is measured against the considerations of whether an action is:

- (1) a Categorical Taking – or denial of all economic benefit,
- 2) an Exaction – a requirement to give up a constitutional right (such as compensation) in exchange for discretionary benefit conferred by the government where the benefit has little or no relationship to the property, or
- 3) a Penn Central type taking.

Any of these types of taking could result from oil and gas ordinance promulgation.

Categorical Takings The classic example of categorical taking (by regulation) is found in *Lucas v. South Carolina Coastal Council*, wherein the state passed regulation regarding beachfront development that, based on the Lucas's lots proximity to the costal shoreline, had the "effect of barring" Lucas from erecting habitable structures on the lots in question. The state trial court determined that the result of the prohibition was to render the subject parcels "valueless," a factual finding that the US Supreme Court also adopted.

The key issue is that the effect of the regulation was the total destruction of the economic value of the property, which differs from the balancing test originally suggested in *Mahon* (Barron, 2015, p. 13-9). The Court emphasized that "when the owner of real property has been called upon to sacrifice *all* economically beneficial uses in the name of the common good, that is, to leave his property economically idle, he has suffered a taking." (Barron, 2015, p. 13-9 citing to *Lucas v. South Carolina Coastal Council*, at 1019). However, in such cases the loss must be total as "mere diminution in the value of the property, however serious, is insufficient to demonstrate a taking".

Barron (2015, p. 13-15) specifically sites to the *SWEPI, LP v. Mora County* case regarding Mora County's banning of hydrocarbon production as an example of a categorical taking. The district court concluded, though the issue was not ripe due to failure to execute process, that the ordinance "effectively destroys all economic value that SWEPI, LP has in its leases," and SWEPI had alleged an injury-in-fact endowing SWEPI with standing to bring a takings claim. The district court echoing the United States Supreme Court in *Mahon* stated "the right to oil and gas consists in right to extract it." In essence that without the right to drill, "an oil and gas lease is worthless". There is some consideration, however, that a claimant that *owns* the minerals – rather than an oil and gas operator such as SWEPI that possesses only a contractual right to develop the minerals – would have a stronger position in presenting a more compelling categorical taking claim.

It is foreseeable that a strict ordinance or zoning requirement that somehow prohibits or severely restricts drilling on some tract of land that has no or little economic value could still be challenged as a takings claim. If the land has little value other than for surface use for mineral extraction purposes, and the land does not have competing adjacent uses that compels a higher public interest, a categorical taking challenge, such as *Whitney Benefits, Inc. v. United States* (Environmental Law Review, 1990) could ensue – especially for pre-existing mineral rights holders.

In *Whitney*, the U.S. Court of Appeals held that restrictions on surface coal mining imposed after the plaintiff acquired property interests constituted an inverse condemnation type taking. This ruling may be of particular interest to oil and gas fracking operations, as the court held against the federal government, despite the federal assertion that other surface uses of the property existed. In particular, the United States asserted that the plaintiff retained the right to mine the coal underground, that the plaintiff maintained the right to ranch or farm, or had the right to exchange plaintiff's coal for federal coal. However, the trial court observed that technological problems

rendered underground mining “exceedingly difficult, if not impossible,” and that references to farming and ranching in that case were speculative and lacked support in the record, and that such assertions were irrelevant since plaintiffs only claimed that the government took their coal rights and not their surface rights.

The issue becomes more obscured when the issue of severed or split estates is considered (i.e. the surface property owner is not the same as the mineral rights owner, or there are multiple mineral rights owners). In many cases, one or more parties other than the surface property owner own the right to the minerals below a property (i.e. a split estate). The ability of a mineral rights holder (particularly oil and gas) to enter onto another’s property for the purpose of exercising the mineral right is held paramount, is an assumed right necessary to exercise the underlying mineral right, and is at the foundation of New Mexico’s Surface Owners Protection Act. However, even in those cases compensation does have to be offered and settled with the affected surface property owner. However, the courts have also recognized that “not every invasion of private property resulting from government activity amounts to an appropriation” (Barron, 2015, p.13-6 citing to *Ridge Line, Inc. v United States*).

The issue of just compensation is also problematic and is further discussed below.

Exactions The issue of exactions should also be considered during oil and gas ordinance promulgation. The courts have recognized the right of local governments to engage in land use planning and regulation. Such prerogatives are “not considered taking if it is within the scope of the police power and does not deny economically viable use of the land. However, when such regulations require property owners to apply for and receive governmental permits, the “unconstitutional conditions” doctrine circumscribes the government’s authority” (Barron, 2015, p. 13-10). That is, “the government cannot “exact” a person to give up a constitutional right in exchange for a discretionary benefit conferred by the government where the benefit sought has little or no relationship to the property”. The issue of exactions is particularly at question “when the permit being requested is more valuable than any just compensation the owner could hope to receive – in such a case the owner is more likely to accede to the government’s demand, no matter how unreasonable.” (Barron, 2015, p. 13-11 citing to *Koontz*).

There are two components to this consideration: the initial condition on development that serves as an alternative to a total prohibition must “further the end advanced as the justification for the prohibition”, and that there must be an “essential nexus” between the “legitimate state interest” being furthered and the permit condition being imposed. (Barron, 2015, p.13-11). Two cases are frequently cited examples of exaction.

In *Dolan v. City of Tigard*, the courts held that the city’s condition that 10 percent of the property be dedicated for the city’s stormwater infrastructure and bikeways in exchange for a permit to expand a hardware store was a taking because the exaction was disproportionate to the request. In *Nolan v. California Coastal Commission*, the court found that the exaction of a beach access across the property in exchange for a building permit to redevelop the site with a larger home constituted a taking. This was because as there was no “nexus” between the building permit and the requirement, as well intentioned as it may have been, for a public beach access across the property.

A hypothetical exaction example for an oil and gas ordinance would be the requirement for an oil and gas operator to donate a parcel of land as a condition for permit issuance. If the end goal was preservation of sensitive habitat, drilling was occurring in such habitat, and replacement habitat was being required, then the legitimate ends test of the prohibition (protection of sensitive habitat), would presumably be satisfied as would the clear nexus test (preservation of habitat for like-habitat being disturbed).

However if the requirement was for dedication of habitat acreage at some multiplier to the acreage affected, the disproportionality test of *Dolan* might be claimed to apply. Similarly, if the initial application was for drilling on a remote portion of scrub land, or in an previously developed area (i.e. no additional critical habitat would be disturbed), and the permit condition was for donation of a parcel of sensitive habitat, the issue of “nexus” could be subject to challenge as a taking by “exaction”. Such a claim might have merit because the requirement exacted sensitive habitat land as a condition for issuing a permit for non-habitat lands, regardless of the legitimate end of habitat protection, and there is no clear nexus for the requirement.

Penn Central Takings and the Balancing Tests In the majority of takings challenges, where some value of the property remains, the assessment of the taking is based on a test that was outlined in *Penn Central Transportation Company v. New York City*, 438 U.S. 104 (1978). In that case, the court applied a multifactor test including:

1. Whether the land use regulation furthers a legitimate state interest
2. Whether the regulation has an adverse economic effect on the property with no alternative or offsetting reciprocal benefits; and
3. Whether the character of the government action places a disproportionate burden upon a single landowner when it should more properly be borne by the community.

(Jourdan and Strauss, 2016, p.131)

These conditions are alternately postulated as three factors of particular significance, with no particular factor being dispositive:

1. The regulations economic impact on the claimant,
2. The extent to which the regulation has interfered with distinct investment backed expectations, including (per Lynch, 2016, p.58) considerations of
 - a. the timing of when the regulation was enacted in relation to when the property interest was acquired,
 - b. the investment-backed expectations must be reasonably probable rather than just speculative,
 - c. whether the owner was operating in a “highly-regulated industry”, and
 - d. whether there was notice of the problem that spawned a need for the regulation.
3. The character of the government action at issue.

(Barron, 2015, p. 13-12)

In the modern oil and gas industry, the ability to conduct hydraulic fracturing is a factor incorporated into a mineral developer’s distinct investment-backed expectations. Without hydraulic fracturing, minerals may remain inaccessible and rendered valueless. Thus, even a partial ban on a particular operation such as fracking that is in widespread use and is not considered “exceptional”, may invoke the consideration of the *Penn Central* threefold tests. In addition, the questions of when a mineral right was acquired with respect to when hydraulic fracturing became a common industry practice and when a regulatory action was taken also needs to be considered. It is likely that any ordinance developed will have been subsequent to the identification and recognition of any subject mineral rights.

In contrast to supporting a Penn Central taking, regulation of hydraulic fracturing is likely to be understood as being a legitimate police power to “protect public health, safety, and welfare”. Exercise of such powers is the type of governmental action that has typically been judged as NOT requiring compensation for the burdens it imposes on private parties who are affected by the regulations (Barron, 2015, p. 13-23), particularly if the regulations are tied to the prevention of nuisances.

As previously mentioned, *Keystone Bituminous Coal Association v. Debenedictis* (Viviano, 2013) provides amplification of the takings test. In that case, although half of the coal deposits were required to be left unmined to provide structural support to prevent subsidence, the Court found that the purpose of the Pennsylvania law was to arrest a significant threat to the public welfare and, therefore, the character of the action leaned heavily against finding a taking. In as much as a property owner is held to an implied obligation that the use of the property will not be injurious to the community, the government’s action was balanced against the economic and investment implications to the property owner. In *Keystone*, although the company’s expectation of profit had been diminished, a profit was still obtainable with the allowed resources while a public purpose was served. (Viviano, 2013, p.9).

Viviano (2013) further speculates that with regard to certain federal oil and gas leases under which surface activities were prohibited after issuance of the federal lease (see *Conner v. Buford*) that “Although the most valuable use is denied, enough rights of the property right remain, such as the ability to directionally drill or pool the lease... that the economic impact factor the test is not met. Likewise, the Lessee’s investment-backed expectations would not be completely diminished. Balanced against the laudable public purpose of environmental protection, a takings challenge is not sustained.” (Viviano, 2013, p. 14)

With regard to challenges to local ordinances under a Penn-Central challenge and the distinct investment backed expectations criteria discussed above, oil and gas drilling and production activities are by nature speculative rather than “reasonably probable” particularly in the Albuquerque Basin, where there was previously no recognized economically developable deposits and the basins de facto status as a “frontier” basin. Additionally, the oil and gas industry is “highly-regulated” so changes in regulatory status and requirements are a reasonably expected occurrence. Additionally, with proper noticing of ordinance and the high level of national interest in hydraulic fracturing issues, notice of the problem has likely been met.

Barron (2015, p. 13-24 and 13-25) also addresses takings stemming from moratoria and development delays. Temporary moratoria may be subject to claims as a temporary taking, particularly when such delays are excessive. However, for a delay to be “extraordinary” or “excessive”, it must be “substantial, since the Supreme Court has held a claim to be unripe even where the application process covering development project required approximately eight years.” (Barron, p. 13-24, citing to *Kawaoka v. City of Arroyo Grande*). The use of a moratorium on oil and gas permit issuance while an ordinance is under development may very well be acceptable if a given and reasonable timeline for ordinance development is expressed.

Compensation for Takings Actions: In general, once a takings claim is determined, the typical remedy is for a financial compensation for loss of the property value. This is based on an underlying premise of fairness and efficiency (Lynch 2018, p.357).

According to Lynch (2018, p. 376) there are only two published cases involving valuation of takings related to fracking regulation takings. The first case (*Bass Enterprises Production Company* 381 F.3d at 1363-65) dealt with the Court of Federal Claims several attempts at placing a value on delays in issuing drilling permits on federal oil leases. The Federal Circuit court first held that no permanent taking had occurred, and then in a second reversal that no temporary taking had occurred either. The second case (*Miller Brothers v. Department of Natural Resources*, 513 N.W, 2d 217 –

Michigan Court of Appeals, 1994), similar to *Connor* cited by Viviano (2013), dealt with a regulatory action that prohibited oil and gas exploration or development with a 4,500 acre area. Plaintiffs were either mineral rights owners within the “protected” area, or developers who had leased the subject rights and had been preparing to develop the area’s resources (<https://www.leagle.com/decision/1994877203michapp6741794>). In that case the court had to address the uncertainty about the value of unproven oil and gas rights, and how to calculate a “just compensation”, with the attempt “to be balancing the competing interests of ensuring that the “public must not be enriched at the property owners’ expense. But neither should property owners be enriched at the public’s expense”. (Lynch, 2018 p. 378)

This presents a significant obstacle for oil and gas mineral right owner’s claims of value. By its very nature and business model, the economic value of the mineral right speculative until such time as exploratory and development activities have been conducted. Additionally, the value of the commodity changes widely with worldwide market conditions, and the mineral right holder or the taking entity may experience either undo gain or loss if such conditions vary widely from the basis on which the economic life of the commodity was determined. As expressed above, the courts frown on unjust enhancement of the property owner as much as a taking that is uncompensated in the whole.

As summarized in the paper’s abstract, Lynch (2018) advances two key points regarding just compensation for fracking-takings claims.

“First, the standard valuation method of fair market value presents difficult, perhaps impossible problems of evidence. This makes valuing fracking-takings claims highly uncertain, which undercuts the efficiency goal of just compensation. Second, even putting aside those evidentiary hurdles, equating the fair market value of taken property with just compensation in the fracking-takings context would frustrate the fairness goal underpinning takings law by risking a windfall for the property owner at public expense and shifting the risks of oil and gas development to the government Moreover, government regulators should not fear takings liability, since threatened liability would violate the theoretical framework underpinning just compensation law and therefore is unlikely to be unduly burdensome.”

Regulatory Approaches to Liability

As suggested by Olmstead and Richardson (2014), “public discussion of the risks of shale development centers on the proper role for regulation: Which risks need to be regulated, and how stringent should that regulation be?” However, liability considerations are also an important driver of operator practices aimed at risk reduction. “This is not to suggest that regulation is not useful and in many cases necessary, but rather that the two systems – regulation and liability – work together to shape patterns of behavior and thereby reduce risks.”

Dana and Wiseman (2015) express this as a dichotomy between a proactive regulatory schema to prevent environmental damage versus an after-action de facto regulation via tort liability for environmental harms.” They also point out that a well-structured liability regime is needed beyond a traditional regulatory approach because regulators lack critical information needed to promulgate regulations, the industry is constantly progressing and evolving, and the activity is in close proximity to population centers.

Olmstead and Richardson (2014, p. 2-4) cite to work of Shavel (1984) in summarizing when a liability approach is appropriate and adequate, and when regulation is needed. They report that Shavel (1984) provides four criteria for evaluating which approach (regulation or liability) is superior in a particular situation:

- Information asymmetry: Where private parties have a greater knowledge about risky activities than prospect regulators do, a liability approach is favored over regulation.
- Ability to pay: If those responsible for harms can escape liability because they are unable to pay to remedy those harms, liability will give inadequate incentives to change behavior.
- Threat of suit: If those responsible for harms can escape liability because they are never sued, a liability approach is once again inadequate. This may in part occur where a harm is widely dispersed, such as fugitive emissions or contamination of rivers and streams from undisclosed spills and releases.
- Costs: Both regulation and liability approaches have costs. Regulation requires the ongoing “public expense of maintaining the regulatory establishment”, while litigation costs can be very high but are only incurred in the case of harm.

Olmstead and Richardson (2014, p. 2-4)

Information Asymmetry conditions are particularly applicable to the oil and gas industry. There are potential effects on surrounding properties and populace that are not contractual parties to the oil and gas operation, the operations are highly technical, the activity occurs underground and under the control of the oil and gas operator, and disclosure requirements may be limited. Increased disclosure and notification requirements and burden/liability shifting, can improve the function of the liability system in information asymmetry situations.

Without disclosure and related requirements, it may be difficult for the potential of a harm having occurred or responsible parties or the time or scale of the harm to be determined. This lack of information discourages initiation of appropriate suits and limits the ability for litigation to proceed (Dana and Wiseman, 2015, p. 132)

Under existing state oil and gas regulation, the initial permit is associated with a variety of posting and notification requirements. In New Mexico, this includes the requirement for the filing of various permits, operational forms, and reports to the state agency. The regulations also require disclosure of hydraulic-fluid component information via FracFocus, but only within 45 days of having completed the operation, and limited to include only information available from material safety data sheets. Additionally, the driller or operator does not have to provide proprietary, trade secret, or confidential business information. Additionally, the New Mexico Oil and Gas division only downloads and archives the FracFocus information on a quarterly basis. The public would then need to request access to such information with a resultant 15 to 30-day time delay – resulting in as much as a four to six month delay in obtaining regulatory required information.

Examples of a more stringent regulatory approach that may help an information asymmetry could include increased local notification requirements or increased notification distances as well as requirements to publically notice particular phases or changes in operational status of the oil and gas operations, such as when hydraulic fracturing or flowback operations may be initiated. These could be required under various nuisance ordinance provisions and/or community right-to-know provisions in any required emergency operations plans.

Liability burden shifting may also help address information asymmetry. Dillard et al. (2018) provides a short summary of the history of nuisance law and its underpinning of private nuisance, legal injury, and tortious conduct and their relation to various concepts of liability. As identified by Dillard et al., writings about tort claims in the 1880s were being influenced by the writings of Oliver Wendell Holmes and others and began to center tort liability around three classes of liability torts: negligence, intentional, and strict liability. (Dillard et al, 2018.) In general, Wrongs to Persons, Estate, and Property generally were actionable if there was a negligent act involved, Personal Wrongs required a demonstration of intentionality, and Wrongs to Property were considered as strict liability torts.

That basic model persists to the present day. In short, to show tortious conduct, the plaintiff must prove that the defendant negligently, intentionally, or through an abnormally dangerous activity interfered with the plaintiff's use and enjoyment of property.

However for a legal injury to have occurred, a plaintiff in Texas must demonstrate that there was substantial interference of the use and enjoyment of the property that caused unreasonable discomfort or annoyance. In Pennsylvania, the standard includes a showing that the conduct was a substantial factor in causing a harm. It also includes that harm must be a "significant harm" or "harm of importance – involving "real and appreciable invasion with the plaintiff's use or enjoyment of his land – it must be more than a mere fear or harm or unease with a defendant's actions" (Dillard et al, 2018).

Negligence: As is the current New Mexico approach to oil and gas liability, a plaintiff in Texas would establish negligence by demonstrating that the defendant had a legal duty, breached that duty, and the damages proximately caused by it. In this approach it is the plaintiffs duty to show that the defendant did or failed to do what a person of ordinary prudence would have not or not done, e.g. to repair or abate a condition under his control. (Dillard et al, 2018 p.5). In an information asymmetry situation, it is difficult for a plaintiff to recognize what duties should be expected, when or why or how a breach of that duty may have occurred, or to define what damages may have resulted.

Intentionality/ Presumptive Liability: Within an intentionality standard, the defendant must not only establish the negligence, but also that the defendant intentionally caused the interference (not just that the conduct led to the interference). This includes demonstrating that there was desire to create the interference and that the interference was substantially certain to result – i.e. that the effects of the conduct (rather than the conduct itself) was unreasonable.

In this regard and the potential interference caused by intentional use of hydraulic fracturing, Pennsylvania addresses concerns with groundwater quality by shifting the burden of proof on to the defendant if pre-drilling baseline water testing is not done. Under this schema, the oil and gas operator obtains and catalogs private well information and performs water sampling and baseline analysis. The obtained information is not publicly available. However, any contamination of groundwater supplies within the prescribed radius is presumed to have been caused by drilling operation (i.e. was intentional) unless the defendant operator can rebut this presumption with the pre-drilling evidence that was collected. This approach of "presumptive liability" (or assumption of intentionality or at least a knowledge that the interference was substantially certain to exist) places the burden of proof onto the operator and therefore likely reduces litigation-related costs and decreases the chance that a wrongdoer will escape liability because the plaintiffs cannot establish causation. (Olmstead and Richardson, 2014, p.6).

Strict Liability: A more common approach to addressing information asymmetry is the imposition of the concept of strict liability. Strict liability is traditionally applied to "ultra-hazardous" activities on the presumption that such activities carry a very high duty of care. (Olmstead and Richardson, 2014). Factors used in determining whether an activity is ultra-hazardous include consideration of:

- the relative possibility of harm to persons, land or chattels of others,
- the seriousness of the potential harm,
- whether or not the extent to which the activity is a matter of common usage,
- inability to eliminate the risk by the exercise of reasonable care,
- whether the risk of the activity outweighs its social value, and
- the inappropriateness of the activity in the area in which it is engaged.

(Watson, 2016 in referencing to the Restatement (Second) of Torts, Section 519).

Common examples of ultra-hazardous activities include the use or storage of explosives, blasting and demolition operations, activities involving hazardous chemicals, disposing of nuclear or chemical wastes, controlled burns, activities involving radioactive materials, and certain types of product defects.

Watson (2016) provides a brief review of cases in which oil and gas related activities have, and have not, been determined to be considered as ultra-hazardous activities. As suggested by Watson (2016) various particular activities may be subject to a strict liability standard, but in most states, courts handle drilling (specifically) under a general negligence standard.

Cases in which the particular activities involved consideration of ultra-hazardous activity include a 1975 case in which water flooding resulted in crude oil leaks and contamination of a well – the court indicated that the facts of the case could have supported an abnormally dangerous activity – but ruled based on nuisance claims. Watson also cites to a 1982 Utah case in which production wastewater migrated and polluted nearby water wells – The defendant was held to be engaged in a dangerous activity through collecting of “toxic formation water” near the plaintiff’s well.

Watson (2016) also cites several cases where the courts held that oil and gas operations were not subject to strict liability considerations. These include:

- a Kansas case wherein the Kansas Supreme Court specifically held that drilling and operation of a natural gas well is not an abnormally dangerous activity after applying the six-fold test described above, and that “the drilling and operation of natural gas wells is a common, accepted, and natural use of the land;
- a Mississippi federal district court ruling following an explosion that occurred during reworking of a gas well, holding that Mississippi authorities have uniformly required proof of negligence against the operator of an oil and gas well.

More specifically, Watson (2016) cites to two Pennsylvania cases (*Ely v Cabot Oil and Gas* and subsequently on precedent *Kanuck vs Shell Energy Holdings*). In *Ely* the court concluded that the plaintiffs failed to substantiate their contention that the natural gas drilling activities, including hydraulic fracturing at issue in the case, are so inherently dangerous that they should be deemed ultrahazardous activities subject to strict liability.” Watson (2016) then provides the findings of the court’s applications of the six-fold test:

- that “a properly drilled, cased, and hydraulically fractured well” creates a “relatively low risk to water supplies”;
- that plaintiffs failed to show a sufficient likelihood that the harm resulting from properly conducted drilling operations will be great; and most importantly,
- that “the risk of harm to groundwater supplies is substantially mitigated when due care is exercised.”

The Court then concluded that the plaintiff’s claims should be “considered under traditional and longstanding negligence principles, and not under a strict liability standard.”

More recently and comprehensively, Watson (2019), provides a summary of status of induced seismicity as wells as oil and gas related strict liability cases. All cases cited were either dismissed, settled, or otherwise closed without the court’s ruling on the issue of applying a strict liability standard. Several of the cases are listed as “pending”.

None of the cases originated in New Mexico, and it is presumed that New Mexico currently address oil and gas suits under a general negligence standard. It is uncertain and problematic whether a local ordinance could be used to establish a jurisdictional standard of care (presumptive liability or strict liability) that is different from a long established legal foundation (negligence) of the state.

Attempts to do so could be judged as preempted in as much as it is not within “the kinds of ... issues with which local governments are traditionally concerned”.

Regardless, a local ordinance could prescribe as ordinance the actions that have resulted from use of such a legal premise in other state jurisdictions without needing to shift a legal premise for liability. In this instance, some type of baseline environmental sampling and/or seismic monitoring for oil and gas operations occurring within the jurisdictional boundaries could be used to help address the information asymmetry problem. Such prescriptive measures would need to be couched as means to address nuisances, as a means to address impact to surrounding property owners from surface activities or resulting surface nuisances, or as necessary in the interest of public safety.

Ability to Pay Dana and Wiseman (2015) express that mandatory financial requirements create an “effective liability regime for unconventional development, especially as to longer term risk, because bonds and insurance can mitigate what we call the “insolvent defendant” problem as well as the “clouded causation” problem.

As suggested by Dana and Wiseman (2015), plaintiffs can only collect tort judgements from solvent, viable, ongoing entities. As a form of self-protection, a corporation, corporate subsidiary, or limited liability company may choose to discount expected liability costs that might be imposed after the expected “life” of the corporate entity or limited liability company. Furthermore, such entities can effectively cap their direct liability by limiting the capitalization even if the shareholders retain significant amounts of capital.

Further complicating the solvency issue, Ho, Shih, et al. (2018) note that:

“it is common industry practices for large operators to transfer ownership of their wells to smaller operators when production rates decline, and regulators typically allow a lease to be transferred as long as the buyer can cover the cost of the bond attached to it. A low bond amount ensures that even a small operator can easily meet bonding requirements; however, these operators are less likely to have the financial means to bear the true cost of P&A [plugging and abandonment] and are also more likely to declare bankruptcy.”

As a result, Dana and Wiseman (2015) suggest that assurance bonds and mandatory insurance for unconventional wells should be a central part of the response to the risks imposed by unconventional drilling. They further suggest that because of the nature and risks associated with unconventional drilling, no firm, regardless of size or resources should be allowed to self-insure, or it should be allowed only to the limited extent that political exigencies requires. Accordingly, using these financial mechanisms allows for a regulatory structure where “the government does not command a particular practice, but rather places a price on an activity associated with risk of harm, or on the harm itself.” (Dana and Wiseman (2015, p.126) As stated by Dana and Wiseman (2015), in market approaches to addressing risk, the sources of risk face financial incentives to mitigate the risks that are subject to their control.

Use of Assurance Bond Requirements in Local Ordinances: Assurance bonds are one kind of market mechanism whereby the operator of a facility is required to post upfront funds or other proof of committed financial resources, which the bondholder can return to the operator once it provides assurance that it closed the facility in a safe way. The incentive to recover the bond motivates, at least in part, responsible conduct and “is an additional financial incentive for corporations or other entities to not walk away and abandon sites, and to instead fulfill their ... obligations”. However, assurance bonds may be underpriced or priced in such a manner that companies may find bond forfeiture economically attractive. Furthermore, sometimes the bond return is based on self-

verification or external verification of satisfaction of the bond conditions are too readily given. (Dana and Wiseman, 2015).

Certain states and localities require bonds for drilling generally, but the bonds that are required vary substantially by locale and often are not sufficient to fully protect environmental resources or remediate damages. Ho, Shih, et al. (2018) note that the difference in bonds versus costs can be exacerbated by the use of blanket bonds and note that in most states, operators are not required to post a separate bond to cover site remediation costs; such costs are expected to be covered by the well bond. Olmstead and Richardson (2014) comment that bonding helps to ensure that operators are held appropriately liable for damages. They also specifically call out that a low bonding amount (such as \$2,500) is certainly too little to cover damages, and that minimal blanket bonds (such as \$25,000) are too low as larger operators may have thousands of wells for which they should demonstrate financial responsibility.

Ho, Shih, et al. (2018) further indicate, “the costs of plugging orphaned wells reveal that average costs exceed average bond amounts in 11 of 13 states and median costs exceed average bond amounts in six of the nine states for which the appropriate data are available. Average bond amounts are more than sufficient to cover the cost of the cheapest projects; however, they fall far short of the most expensive projects”. As to whether bond amounts should, in general, be raised, Ho, Shih et al. (2018) argue that even if a bond is lower than P&A costs, firms still have an incentive to plug if there are litigation costs or reputational costs from not plugging. They also suggest that bond amounts be adjusted according to projected liabilities as has been done for surface mining projects in the US, and as a few states have done by adjusting bond amounts based on well depth.

Specific to the Kansas data set, Ho, Shih, et al (2018) determined that a 1,000-foot increase in depth was associated with a 34.4% increase in plugging costs. They also note that plugging costs for wells in urban areas are also more expensive than for wells on barren land, grassland, or forested land. Gas wells were also found to be 10.1% more expensive to plug than oil wells.

Ho, Krupnick, et al (2016) and Ho, Shih, et al., (2018) provide detailed studies of the evaluation of bonding requirements for oil and gas wells in the United States, and particularly with regard to the adequacy of such programs to address plugging and abandonment of inactive wells. Ho, Shih, et al. (2018) looked at the average costs of plugging and abandonment for 13 states where the information was adequate to perform cost factor analysis (New Mexico was not included in that analysis). The mean costs for single well abandonment ranged from \$4,562 to \$66,285. Low costs ranged from less than \$1,000, while the maximum costs was cited as \$575,945. They further identified, based on the Kansas data set, that several factors influenced the cost: most notably total well depth, but also well age. Oil price is also a correlative factor.

Use of Mandatory Insurance Requirements in Local Ordinances: Mandatory insurance is another market risk mechanism, and generally a more effective one than assurance bonds, especially for longer-term risks. Insurance provides a mechanism for reducing risk to the extent insurance premiums are set to reward behavior that creates less risk and penalize behavior that creates more risk. As a complement to bonds, mandatory environmental liability insurance may be required, as has been the required for other industries such as nuclear power operations and offshore drilling operations.

A distinct advantage in mandatory insurance is that a claim against the insurance may be brought at any time as long as the event occurred during the period of coverage. Furthermore, according to Dana and Wiseman (2015, p.141) mandatory insurance is an appropriate action because there will always be some “inherent, irreducible risk associated with unconventional development, however much the entities involved attempt to take care. Moreover, unconventional development in some areas (such as near major population centers, ecologically sensitive areas, or areas with more

vulnerable groundwater supplies) is likely to involve more nonreducible risk than development in other areas.”

Often, in frontier areas, a small-business, independent operator is the one willing to take the initial risk to discover new resources. Dana and Wiseman (2015, p.158-159) address the concerns that financial assurance requirements (particularly mandatory liability insurance) would disadvantage such smaller businesses:

- self-insurance, while cheaper than buying third-party insurance, may not be an option for smaller less-capitalized firms,
- smaller firms likely do not have the buying leverage of larger corporations, and
- smaller firms may not have the risk management capacity that third-party insurers would require.

However, because of the nature and risks associated with unconventional drilling, Dana and Wiseman (2015, p.158) hold that no firm, regardless of size or resources should be allowed to self-insure, or it should be allowed only to the limited extent that political exigencies requires. This is because in many cases, operational and production management interests may outweigh concerns for safety and risk management, objective third-party oversight (i.e. by the insurer) provides a significant benefit, and due to the nature of the risk, there may be a social good in favoring larger firms that can provide a certain economy of scale associated with risk reductions.

Regulatory and Financial Requirements In New Mexico: Ho, Krupnick, et al (2018) provide a survey of regulatory, financial, and inactive well regulations in 22 oil and gas states and on BLM lands. New Mexico requirement and standards are included in the referenced survey. In general, the survey shows that NM ranks moderately or above average in most of the regulatory factors reviewed. Ho, Krupnick, et al (2018) provides a series of figures tables showing the relative rankings for the 22 states for the various regulatory and financial requirements. NM ranks 7th for the number of regulatory elements addressing inactive well risks (*ibid*, Figure 4); 13th with respect to the stringency of quantitative regulatory elements (*ibid*, Figure 5); and 3rd with respect to the stringency of qualitative regulatory requirements (*ibid*, Figure 6).

New Mexico is represented as allowing only three types of financial assurances: surety bonds, letters of credit (i.e., self-insured), or cash deposits (*ibid*, Table 4). New Mexico includes well depth, location of wells, the number of inactive wells, and compliance history as factors used in determining individual and blanket bond amounts (*ibid*, Table 5). Individual bonds are a minimum of \$5,000 plus a factor for well depth, while the minimum blanket bond minimum is \$50,000 (*ibid*, Maps 2 and 3). New Mexico also is considered by those authors as having relatively stringent, prescriptive site restoration requirements (*ibid*, Map 10). The financial assurance requirements are detailed in the state administrative code NMAC 19:15.8.9 and was previously summarized in an earlier table of this document.

With respect to local governments having the ability to require bonding and insurance above and beyond or in addition to state required amounts, Dana and Wiseman (2015, p. 109 footnotes) provide several examples where such duplicate requirements are in local ordinance. Arlington, Texas requires a \$100,000 cash, bond, or letter of credit for operators with one well per site, and also requires energy companies to provide environmental liability insurance of at least \$5 million per loss. Fort Worth, Texas requires a blanket bond of \$150,000 for companies drilling 1-5 wells and during well production, and a \$100,000 bond for operators with up to 75 wells.

Furthermore, a review of other New Mexico Ordinances indicates the following existing local ordinance financial assurance requirements:

Entity	Bonding	Comprehensive Liability	Pollution/Environmental
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<i>Rio Arriba County</i>	<i>Not Specified</i>	<i>Not Specified</i>	<i>\$1,000,000 / \$2,000,000</i>
<i>Santa Fe County</i>	<i>\$50,000</i>	<i>\$10,000,000</i>	<i>\$10,000,000</i>
<i>Aztec, Nm</i>	<i>Not Specified</i>	<i>\$500,000 / \$1,000,000</i>	<i>Not Specified</i>
<i>Bloomfield, NM</i>	<i>Not specified</i>	<i>(Maximum tort claims)</i>	<i>Not Specified</i>
<i>Carlsbad, NM</i>	<i>\$100,000</i>	<i>\$5,000,000</i>	<i>Not Specified</i>
<i>Hobbs, NM</i>	<i>\$100,000</i>	<i>\$5,000,000</i>	<i>Not Specified</i>
<i>Lovington, NM</i>	<i>\$25,000</i>	<i>\$5,000,000</i>	<i>\$1,000,000/\$5,000,000</i>
<i>Farmington, NM</i>	<i>\$20,000</i>	<i>\$5,000,000</i>	<i>Not Specified</i>

The courts have yet to hear or determine whether duplicate requirements, such as financial assurances being required by a local ordinance in addition to state-required financial assurances, might also be a preemption issue.

Threat of Suit

Dana and Wiseman (2015) hold the position that the effectiveness of risk management being driving by a threat of suit is constrained because:

“plaintiff’s lawyers and government lawyers who might consider bringing a liability case will only want to do so if there is a reasonable possibility of damages recovery. If the potential defendants are insolvent or lack insurance, there will be no rational reason to proceed with litigation and no reason to invest in testing the contours of liability.”

Dana and Wiseman (2015) call to attention that most entities that undertake unconventional well development are organized as limited liability companies, and many of these corporations will be defunct or dissolved by the time the tort process is able to identify liability and results in judgement. As stated by Dana and Wiseman (2015), absent mandatory insurance, “the effectiveness of liability risk management is uncertain because of potential defendants’ ability to judgement proof themselves using corporate structure and causation problems especially as to long tail liability.”

Furthermore, in areas with multiple oil and gas operations, an additional barrier to bringing suit is one of a “clouded causation” problem and the burden on the plaintiff to prove that a given defendant specifically caused the harm. Where there are multiple potential sources of contamination, such as occurs in “boom” regions, attributing specific harms to specific defendants and proving actual and “proximate” causation can be an uphill battle.

Combined, these factor tend to reduce the likelihood that a corporation or limited liability company will need to face liability in the long term, years after its operations have ended, and thus limits the effectiveness of tort liability as an effective damage recovery mechanism. Dana and Wiseman (2015, p.138) are of the opinion that “the difficulty of imposing effective liability for unconventional development-related harms may explain why, reportedly, some of the actors in the unconventional oil and gas market have avoided purchasing environmental insurance, and others have only purchased relatively modest coverage.

CostsAs stated by Olmstead and Richardson (2014) “ almost all of the tools and policy options discussed above for resolving information asymmetries, addressing inability to pay, and preventing operators from escaping liability also help reduce the costs of litigation. Information disclosure

regulations lessen the need to rely on expensive discovery to acquire information. Burden shifting rules, in theory, put the burden of evidence gathering on the party able to meet it at least cost.”

Nuisance Regulations

Energy companies increasingly have been the target of nuisance suits alleging the drilling operations were a nuisance to nearby residents including such things as bright lights on drilling rigs, vibrations from drilling, odor from condensate tanks, exhaust fumes from trucks, dust from construction, and noise from compressor stations. (Dillard et al, 2018, p.2). As a result, oil and gas companies frequently apply best practices including construction of sound walls and visual barriers, impose time-of-day restrictions on various operations, use voluntary setbacks, and establish conservation easements and mitigation banks (though such permit conditions may verge upon potential claims of exaction, as discussed above, if made mandatory rather than being voluntary). (Barron, p. 13-27).

Ritchie (2014) notes that New Mexico state government has expressed no interest in regulating local externalities such as traffic, noise, light, and other visual impacts. Ritchie (2014) notes that many of the primarily local issues can be addressed with reasonable setback requirements between the well and residence or other type of specified use, though in Colorado the state had developed statewide rules for such nuisances in the interest of uniformity and regulatory certainty.

With respect to other indirect regulation, a preemption or takings claim based on regulations addressing nuisance considerations would likely be difficult to sustain. In *Mora*, the district court specifically called out that state regulations did not address issues such as traffic, noise limitations, nuisance issues from sound, dust, chemical run-off, or impact on neighboring properties. Consequently, the court indicated room for “concurrent regulation” with the state. Additionally, industry participants have expressly recognized the role that federal, state, and local governments play in mitigating the impacts of oil and gas development and routinely and voluntarily implement best management practices to avoid such nuisance suits.

Consequently, use of local ordinance to mitigate oil and gas nuisance issues will most likely be upheld if challenged under preemption or takings claims.

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Abbreviations

EIA – Energy Information Administration

EMNRD – NM Energy & Minerals Department

EPA – US Environmental Protection Agency

GWPC – Ground Water Protection Council

GWQB – Ground Water Quality Bureau of the NM Environment Department

IOGCC – Interstate Oil and Gas Compact Commission

MSDS – Material Safety Data Sheets

NMED – NM Environment Department

OCD – Oil Conservation Division of the NM Energy & Minerals Department (EMNRD)

PW – Produced water

SDS – Safety Data Sheet

SRO – Secondary recovery of oil

SWD – Salt water disposal well

TDS – Total dissolved solids

Appendices

Appendix A

Bernco West Quadrangle. (Connell, 2006) Plate 1-Surface Geology; Plate 2 Cross Sections

Geology of the Bernalillo and Placitas quadrangles, Sandoval County (Connell, et.al.) Plate I, II, III

Geology of Alameda Quadrangle. (Connell, 2000) Bernalillo and Sandoval Counties

Geology of Dalies quadrangle. (2000 revision) Bernalillo and Valencia Counties

Geology of Tome quadrangle. (Rawling, McCraw 2004) Valencia County

Geology of Tome NE quadrangle (Rawling, McCraw 2004) Valencia County

Geology of Belen quadrangle (Rawling 2003) Valencia County

Appendix for Drilling and Oil and Gas Production Techniques

Chemicals most often used for hydraulic fracturing from the FracFocus database (GWPC and IOGCC, 2019).

<u>Chemical Name</u>	<u>CAS</u>	<u>Chemical Purpose</u>	<u>Product Function</u>
Hydrochloric Acid	007647-01-0	Helps dissolve minerals and initiate cracks in the rock	Acid
Glutaraldehyde	000111-30-8	Eliminates bacteria in the water that produces corrosive by-products	Biocide
Quaternary Ammonium Chloride	012125-02-9	Eliminates bacteria in the water that produces corrosive by-products	Biocide
Quaternary Ammonium Chloride	061789-71-1	Eliminates bacteria in the water that produces corrosive by-products	Biocide
Tetrakis Hydroxymethyl-Phosphonium Sulfate	055566-30-8	Eliminates bacteria in the water that produces corrosive by-products	Biocide
Ammonium Persulfate	007727-54-0	Allows a delayed break down of the gel	Breaker
Sodium Chloride	007647-14-5	Product Stabilizer	Breaker
Magnesium Peroxide	014452-57-4	Allows a delayed break down the gel	Breaker
Magnesium Oxide	001309-48-4	Allows a delayed break down the gel	Breaker
Calcium Chloride	010043-52-	Product Stabilizer	Breaker

Choline Chloride	000067-48-1	Prevents clays from swelling or shifting	Clay Stabilizer
Tetramethyl ammonium chloride	000075-57-0	Prevents clays from swelling or shifting	Clay Stabilizer
Sodium Chloride	007647-14-5	Prevents clays from swelling or shifting	Clay Stabilizer
Isopropanol	000067-63-0	Product stabilizer and / or winterizing agent	Corrosion Inhibitor
Methanol	000067-56-1	Product stabilizer and / or winterizing agent	Corrosion Inhibitor
Formic Acid	000064-18-6	Prevents the corrosion of the pipe	Corrosion Inhibitor
Acetaldehyde	000075-07-0	Prevents the corrosion of the pipe	Corrosion Inhibitor
Petroleum Distillate	064741-85-1	Carrier fluid for borate or zirconate crosslinker	Crosslinker
Hydrotreated Light Petroleum Distillate	064742-47-8	Carrier fluid for borate or zirconate crosslinker	Crosslinker
Potassium Metaborate	013709-94-9	Maintains fluid viscosity as temperature increases	Crosslinker
Triethanolamine Zirconate	101033-44-7	Maintains fluid viscosity as temperature increases	Crosslinker
Sodium Tetraborate	001303-96-4	Maintains fluid viscosity as temperature increases	Crosslinker
Boric Acid	001333-73-9	Maintains fluid viscosity as temperature increases	Crosslinker
Zirconium Complex	113184-20-6	Maintains fluid viscosity as temperature increases	Crosslinker
Borate Salts	N/A	Maintains fluid viscosity as temperature increases	Crosslinker
Ethylene Glycol	000107-21-1	Product stabilizer and / or winterizing agent.	Crosslinker
Methanol	000067-56-1	Product stabilizer and / or winterizing agent.	Crosslinker
Polyacrylamide	009003-05-	"Slicks" the water to minimize friction	Friction Reducer

Petroleum Distillate	064741-85-1	Carrier fluid for polyacrylamide friction reducer	Friction Reducer
Hydrotreated Light Petroleum Distillate	064742-47-8	Carrier fluid for polyacrylamide friction reducer	Friction Reducer
Methanol	000067-56-1	Product stabilizer and / or winterizing agent.	Friction Reducer
Ethylene Glycol	000107-21-1	Product stabilizer and / or winterizing agent.	Friction Reducer
Guar Gum	009000-30-0	Thickens the water in order to suspend the sand	Gelling Agent
Petroleum Distillate	064741-85-1	Carrier fluid for guar gum in liquid gels	Gelling Agent
Hydrotreated Light Petroleum Distillate	064742-47-8	Carrier fluid for guar gum in liquid gels	Gelling Agent
Methanol	000067-56-1	Product stabilizer and / or winterizing agent.	Gelling Agent
Polysaccharide Blend	068130-15-4	Thickens the water in order to suspend the sand	Gelling Agent
Ethylene Glycol	000107-21-1	Product stabilizer and / or winterizing agent.	Gelling Agent
Citric Acid	000077-92-9	Prevents precipitation of metal oxides	Iron Control
Acetic Acid	000064-19-7	Prevents precipitation of metal oxides	Iron Control
Thioglycolic Acid	000068-11-1	Prevents precipitation of metal oxides	Iron Control
Sodium Erythorbate	006381-77-7	Prevents precipitation of metal oxides	Iron Control